ON THE COVER

AS PART of an expansion and modernization program, National Tube Company has put into use at its Lorain, Ohio, works four new Bessemer converters that are notable because they are the first of these pneumatic steelmakers of all-welded construction. Using molten blast-furnace iron as raw material, each produces 25 tons of steel in less than twenty minutes. With the aid of a special deoxidizing process developed by the company, an excellent grade of steel for pipe is turned out.

Apart from this, there is increasing evidence that the pioneer Bessemer process, which was threatened with extinction when the open-hearth furnace came into service half a century ago, is not only holding its own but is even improving its position. Research initiated by Jones & Laughlin Steel Corporation, and later taken up by United States Steel Corporation, has given rise to a new steelmaking technique called turbo-hearth that combines the best features of the Bessemer and open-hearth methods. With it, steel of open-hearth quality, which means low nitrogen, phosphorus, and sulphur content, has been produced in twelve minutes.

Following initial J & L experiments with small vessels, U. S. Steel conducted tests with a 30-ton unit that is described as shaped somewhat like a giant coffee maker. Inside the steel casing is a lining of magnesite bricks that can withstand temperatures exceeding 3000°F. Like the Bessemer converter, the turbo-hearth is suspended on trunnions to permit tilting. The Bessemer principle of supplying fuel in the form of compressed air is followed, but the jets are placed so as to provide for surface blowing of the molten-iron charge instead of pushing the air through it from the bottom, as in the Bessemer. Enough oxygen is made available to burn all the carbon to carbon dioxide inside the vessel, whereas in the ordinary converter it is burned only to carbon monoxide. The resultant greater heat does a quicker, better refining job.

U. S. Steel reports that, when using standard basic pig iron as the charge, the turbo-hearth yields steel containing a minimum of undesirable elements. Exhaustive experiments have indicated that it equals open-hearth steel of similar composition. Just as important is the fact that the new method is fast yet flexible. The output of one 30-ton turbo-hearth exceeds that of a 225-ton standard open-hearth furnace. Many or few vessels can be utilized, depending upon the demand for steel. Fast as it is, the process can be still further speeded up by adding oxygen to the air blast.

Commercial turbo-hearth production of steel is not here yet, but it is not far away. Meanwhile, agreements are being reached on the patents relating to it.

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Red, Green, and Black Zinc Ore

Two Deposits in Northern New Jersey Yield a Type of Ore that Is Found Nowhere Else

Walter P. Gillingham

MINING, 1870 STYLE

An open pit in the Mine Hill ore body at Franklin as it looked 80 years ago. The dark objects in line along the base of the light-colored cliff are workmen engaged in breaking the ore by hand and shoveling it into horse-drawn wagons, two of which are shown at the bottom of the picture. The Sterling Hill property was worked in a similar manner.

EARLY VIEWS

The town of Franklin was originally called Franklin Furnace because in Revolutionary War days it was the site of a furnace to which the district's iron ores were brought for smelting. It was organized as a borough in 1913 and given its present name. The view at the top was taken in 1904 from a hill about 1½ miles southeast of the community. The open pits by which the deposit was once worked are located just right of the main cluster of buildings. The lower picture shows the Sterling Hill Mine at Ogdensburg, about 3 miles south of Franklin, as it appeared in 1915. It also carries the scars of open cuts made by early-day miners.

IT IS night in the city of Newark, N. J. Inside a house on a quiet residential street a man sits at a table before a crackling fire. The yellow glare of a flickering candle casts a dim light in the room. From the street come the muffled sounds of a horse's hoofs and the rattle of carriage wheels. The man pulls his chair closer to the table and begins to write to the editor of the *Philadelphia Inquirer:*

December 10, 1849

MR. EDITOR—

Some of those who sneer at the good State of New Jersey and consider her nothing but a sand flat, producing peas and watermelons, should take the jaunt, from which I have just returned, to the mountains of Sussex county, and there see the mineral riches . . . the extent of which, were they fully set forth, would be deemed almost fabulous . . . .

My object was to examine the mines of the Sussex Zinc Companies, which have recently excited so much attention; and in company with a party of friends . . . proceeded on to Franklin, the seat of the mines.

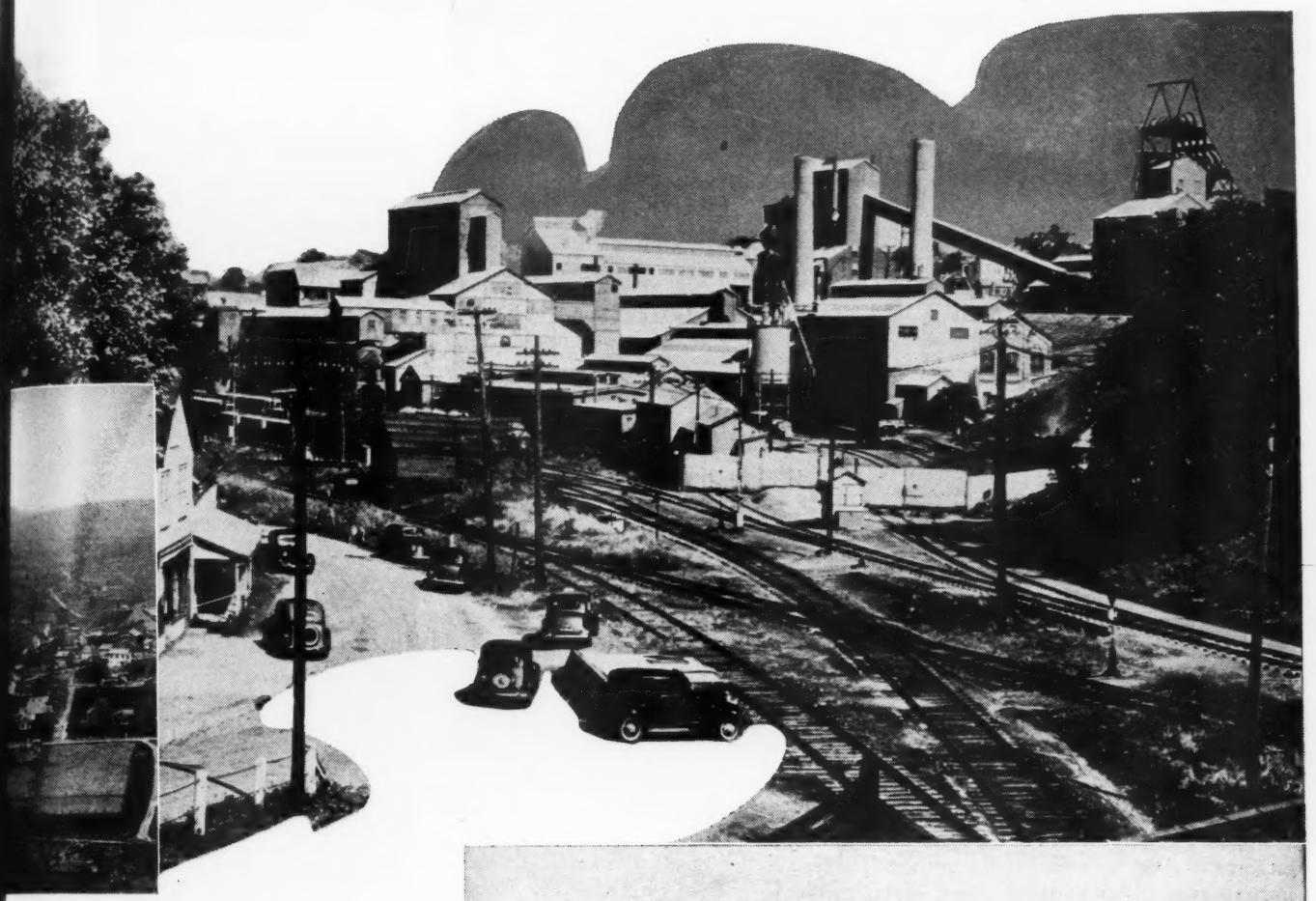
The first mine we visited is called Sterling Hill; the vein of red oxide which crops out on its side is about six feet thick, and descends almost perpendicularly, growing thicker as it descends . . . (it) is estimated by geologists to be about two thousand feet in depth . . . about six hundred feet in width . . . . In fact, there is ore enough in this one mine, even with immense consumption, to last for several generations . . . .

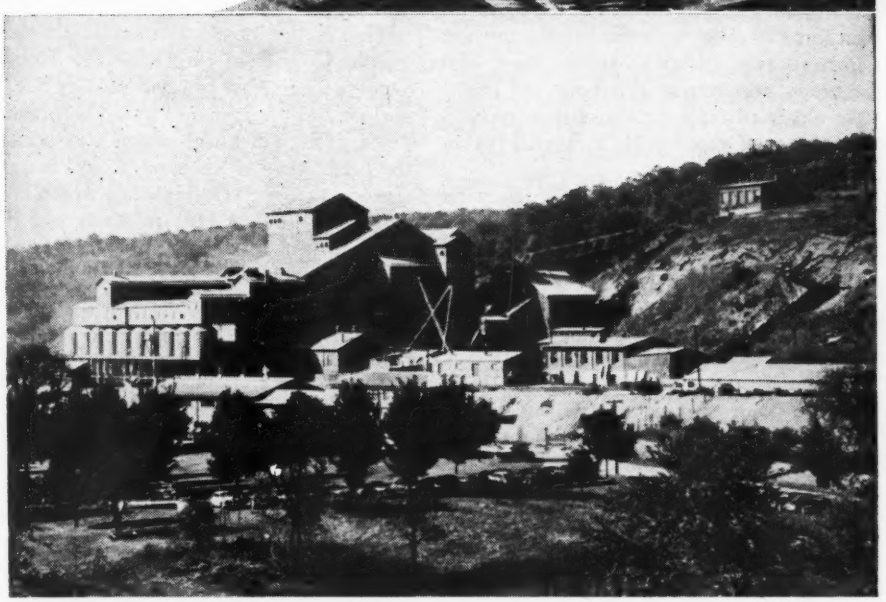
We next visited the other mine of the Company, called Mine Hill . . . and there saw even more startling developments of mineral resources, the vein being of great thickness and standing almost like a wall on the side of a hill, upwards of two hundred feet high. It can be mined at an expense almost trivial . . . . The Red Oxide of Zinc is found in no other part of the known world. . . the richest ores of Zinc ever discovered.

We visited . . . the trial furnace erected by the Companies, at Newark, for reducing the red oxide of zinc . . . (which) has heretofore never been productively worked . . . and from the results which we saw obtained, I feel confident they will be able to compete with the world in the manufacture of zinc, either as a metal in its various forms, or as a paint, with profit to themselves and benefit to the country, inasmuch as all zinc now used is imported.

Yours truly,
A JERSEYMAN

The writer of this letter did not pen it in the interests of interstate bickering. He had just seen two zinc deposits whose size, richness, and type of mineralization had impressed him greatly. And, more clearly than many of his period he foresaw the tremendous impact they were to make on the economy of his growing country. The ore bodies so enthusiastically described more than 100 years ago





FRANKLIN AND STERLING HILL MINES TODAY

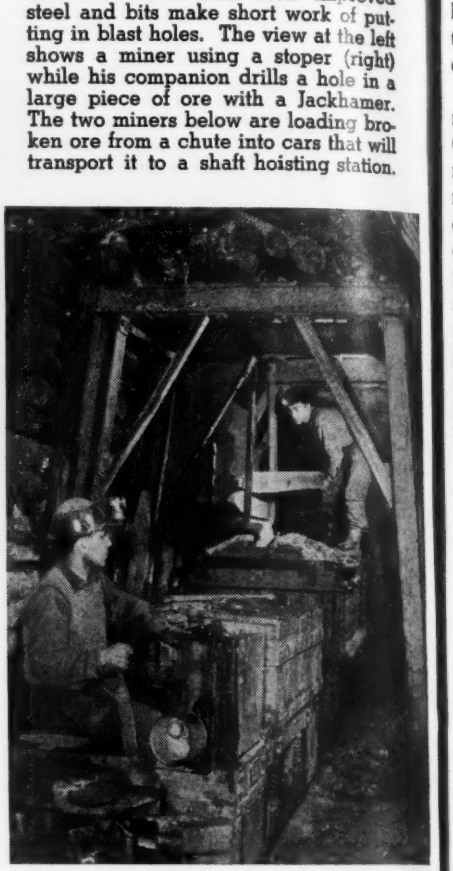
Modern surface plants at both properties receive the ore as it is hoisted and separate its mineral components, which are then sent to the company smelter at Palmerton, Pa., for extraction of the metal. The views show the mine and mill at Franklin (top) and the surface plant at the Sterling Hill property.

are located in northern New Jersey, within two hours' drive from New York City. Now known as the Franklin and Sterling Hill mines, they are owned and operated by The New Jersey Zinc Company. Together they form one of the largest sources of zinc in the country and make the region the nation's third largest in the production of zinc ore.

The unusual thing about the deposits is their unique mineralization. Where most zinc minerals exist as sulphides, they are made up of oxides and silicates. Where most of them are dull black or pale amber in color, they are black, green, and red, combined with other varicolored metallic substances. Where most zinc ore bodies are of fairly uniform composition, they are an intimate mixture of a large number of minerals. Where most of them carry minor amounts of lead, cadmium, copper, etc., they are free of these metals.

The three important minerals in the ore are franklinite, zincite, and willemite. Franklinite, a complex oxide of zinc, iron, and manganese, is jet black in color; zincite, the oxide of zinc, is red; and willemite, the silicate, is green. These three occur as small crystals that are jumbled together in every conceivable combination to make up the deposits. They also contain a bewildering array of other minerals—more than 130 different ones having been identified. For this reason the area has been called the mecca of mineralogists. But for the same reason they resisted for 200 years every attempt to apply them commercially.

The history of the ore bodies goes back to the early days of our nation. In 1609, Henry Hudson sailed the *Half Moon* into New York Bay and up the river that now bears his name. A few years later the Dutch began sending trading expeditions to the new land. They established the colony of Nieuw Amsterdam (New York), from which they invaded New Jersey to barter with the Indians. They were also interested in minerals, and records of that period indicate that their scouting parties found and explored some massive outcrops located 50 miles northwest of New York—the Mine Hill and Sterling Hill deposits, as they were



MINING THE ORE

Current mining methods are a far cry from those practiced when the deposits were first worked. Modern air-operated rock drills with their improved steel and bits make short work of putting in blast holes. The view at the left shows a miner using a stoper (right) while his companion drills a hole in a large piece of ore with a Jackhamer. The two miners below are loading broken ore from a chute into cars that will transport it to a shaft hoisting station.

originally called. Unable to determine the nature of the minerals, they moved on some 20 miles westward to the present Port Jervis district where they discovered and mined a copper ore body. An old road built by those men to haul the ore to Kingston, N. Y., is still partly preserved.

In June, 1664, the Duke of York, with a few strokes of his quill, created and granted the region between the Hudson and Delaware rivers to John Berkeley and Sir John Carteret In 1676 the land, called *Nova Caeserea* (New Jersey) was divided, Carteret taking the easterly section and Berkeley the western. In 1680, William Penn and eleven associates purchased the Province of East Jersey for 3400 pounds at public auction. This area, in which the Mine Hill and Sterling Hill deposits are located, was divided and subdivided down through the succeeding years as parts of it were sold or passed from father to son.

The Sterling Hill ore body got its name from William Alexander, the Earl of Stirling. An English nobleman by birth, he came to America in 1760 to take over a large New Jersey estate he had inherited from his father. The land included several iron mines and the zinc deposit. Despite his origin, Lord Stirling sympathized with the colonists in the War of Independence. He joined Washington's army and rose to the rank of major general, distinguishing himself at the battles of Long Island, Trenton, Brandywine, and Monmouth. From the iron mines on his property he produced metal for molding cannon sorely needed by the Continental Army. He also attempted to work the zinc deposit, but failed.

One of the most prominent citizens of Sussex County at that time was Robert Ogden, a neighbor of Lord Stirling's. The former built a mansion near the present town of Ogdensburg, which was named for him. One of his sons, Elias, bought the tract close to Ogdensburg which contains the Sterling Hill ore body but did little towards developing the latter. Probably the first man to realize the value of Mine Hill was Joseph Sharp, whose father willed him the farm on which it was located. Unfortunately, he and others of that period, probably misled by the strong resemblance between the predominating black franklinite in the ore and the black magnetite so plentiful in Sussex County, thought that Mine Hill was an iron deposit. Although he spent much time and effort trying to produce iron, he never succeeded, and finally had to dispose of the property to satisfy his creditors.

Joseph Sharp was not destined to be the only one to lose the mineral wealth he possessed. Others after him spent years and great sums of money in vain attempts to solve the perplexing nature of the ores. In 1810 the lands with both mines passed into the hands of Dr. Samuel Fowler, a son-in-law of Robert Ogden. Doctor Fowler appreciated their potential value, but he did not know what the ore was or how to utilize it. He, too, thought it was iron, but when he tried to smelt it he failed. He was in the position of a man who has a million dollars in a safe but can't find the combination to unlock it. At that time, most of the information about mining and smelting available in this country had come from Europe, where the industry had been carried on for centuries. But the best of her experts in that field were unfamiliar with the true character of the ores because none like them had ever been discovered before.

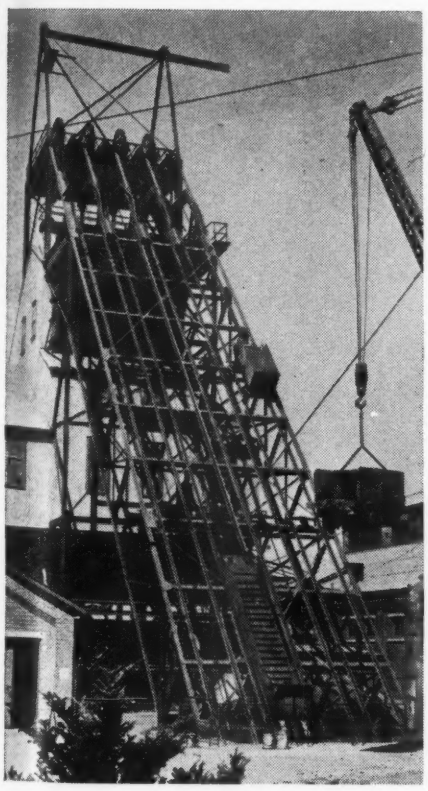
The obstacles which confronted Doctor Fowler in his efforts to exploit the deposits were enormous. In order to obtain metal from the ore, he had to smelt it in a furnace. Yet he could not fuse a piece of ore made up of zinc, iron, manganese, and other elements, each requiring a different degree of heat for reduction. Added to those difficulties was a lack of understanding of the structure and composition of the ore bodies. Because some of the veins or ore shoots were composed of one or another of the principal minerals, uncontaminated by the others, it was believed that that condition persisted, and early mining was done under that misconception. Years later it was proved that these "stringers" constitute only a small part of the deposits and that the main mass consists of an admixture of all three minerals.

During most of his active life, Doctor Fowler exerted every effort to find some practical application for his ores and to put the mines on a paying basis. He

made countless experiments, and in 1830 did succeed in doing one thing: he ground some of the zinc oxide and produced a "bluish-white powder" which he substituted for white lead in paint for his house. That is probably the first time zinc oxide from American-mined ores was used for house painting.

While Doctor Fowler was serving as a member of the House of Representatives Congress passed a law authorizing the making of a set of standard weights and measures for use in the Government's custom houses. "New Jersey Red Oxyde of Zinc" was alloyed with copper to make the brass for those weights. The ore came from the "Weights and Measures" opening of the Mine Hill, and its smelting at the Washington arsenal in 1838 marked the first commercial production of zinc metal in the United States.

Doctor Fowler did not live to see the culmination of his work. Because of his failing health he disposed of the properties in 1836, a few years before his death. Later, his son Col. Samuel Fowler acquired title to the deposits Instead of trying to operate them single-handed, as had his father, he brought together a group of experts whose talents would stand a better chance of mastering the complex ores. In 1848 those men formed The Sussex Zinc & Copper Mining & Manufacturing Company, predecessor of The New Jersey Zinc Company.



FRANKLIN MINE HEADFRAME
Ore is brought to the surface through a 4-compartment shaft that slopes about 47 degrees from the horizontal and extends 1520 feet into the ground. Steam-driven hoists in a building back of the headframe pull 6-ton skips from the bottom to the top in a matter of about 30 seconds, the hoisting speed being 3000 feet per minute.

Lack of adequate transportation in the early days was another handicap in the exploitation of the Mine Hill and Sterling Hill ore bodies. Prior to the beginning of the nineteenth century there was but one way of getting the ore out, and that was by a long, laborious haul over the mountains in horse-drawn wagons. Then, in 1822, George P. McCullock went fishing on Great Pond (now called Lake Hopatcong) and had an idea that started the chain of events which led to the building of the Morris Canal.

McCullock reasoned that the volume of water spilling out of the lake was sufficient to maintain a canal running east to Newark and west to the Delaware River. Such a waterway would make it possible to bring coal from the Pennsylvania mines to the iron forges of Sussex and Morris counties, at that time virtually shut down because of a shortage of fuel. Between Rockaway and Andover, a 15-mile stretch of the proposed canal, were 56 forges, most of them idle because they had exhausted the region's timber resources in making charcoal for fuel. Coal would revitalize the industry.

Construction of the waterway began in 1825 and ended six years later. To negotiate the 55 miles between the Delaware and Hudson rivers, the canal had to follow a winding course nearly twice that distance and go up and down the sides of mountains by a series of inclined planes. Masonry was of stone held together by lime mortar, concrete as used today being unknown. Compressed-air drills or dynamite were not available—holes were put in rocks by hand-held drills, filled with black powder, and tamped with clay. After dropping a glowing coal on the clay, the blaster ran for cover. All excavated material was removed manually, and workers labored from sunrise to sunset for 90 cents a day or less.

The Morris Canal was opened to traffic in 1831, giving Mine Hill and Sterling Hill a route over which they could easily move their ores to a smelter. Wagons began to rumble from the mines up the side of Mount Morris to the north end of Lake Hopatcong, whence barges floated them the length of the lake and into the canal for the trip to Newark. A few years later, railroads began pushing their way toward the rich mining district of Sussex and Morris counties, thus ending the transportation problem.

By 1848 there still was no clear picture of the composition of the ore bodies. Franklinite was thought to be an ore of iron, and its zinc content was deemed a detriment. Zincite was believed to be the only valuable mineral in the ore. Willemite, at first considered of little worth, actually proved to be one of the most valuable of the constituents. So The Sussex Zinc & Copper Mining & Manufacturing Company was formed with the idea of carrying on experiments to develop processes for making zinc products from the ores. A small plant was built at Newark in 1848 in which all the known methods of smelting were tried in an effort to obtain metallic zinc in paying quantities. Failing in this, the company next endeavored to produce zinc oxide for use as a pigment in paints. At that time it was made only in France. The method used there was, at the best, an expensive one and involved melting metallic zinc and burning the resulting vapors. By 1852 the Sussex men had discovered a way whereby they could make zinc oxide from the ores of the district without the necessity of first converting them to zinc metal.

Lacking a market for the new product, the company prepared white and tinted pastes of zinc oxide and demonstrated to the paint industry that they were superior to the pigments then available. Their coatings were not only of improved whiteness, tint retention, and fume resistance but also remained in suspension, a desirable quality. Manufacturers tried them, and within a few years used them to make paints which they could sell in thinned condition ready for application —the beginning of the ready-mixed-paint industry.

Assured of financial success through the development of the zinc-oxide process, the organization next turned its attention to the iron and manganese in the ores. By 1855 the New Jersey Zinc Company, as it was then known, had produced an alloy of iron and manganese from the residue of the zinc-oxide furnace. The new alloy—a bright, shiny, hard substance—was akin to the German spiegeleisen. Like in the case of zinc oxide, it found no market at the start. Subsequently it was used to build safes of such hardness that burglars' drills could not pierce them and to increase the strength of railroad-car wheels. The invention of the Bessemer process at a still later date created a large and continual demand for spiegeleisen to give the steel strength, hardness, and other desirable properties.

In 1888, John P. Wetherill succeeded in developing a method of concentration by which Mine Hill and Sterling Hill ores could be separated into their respective components. It was based on the fact that franklinite is slightly magnetic while the other minerals are not. He constructed a separator in which strong electromagnets were mounted above a belt placed a few inches above and at right angles to a belt conveying the crushed ore. As the latter passed underneath the electromagnets, the franklinite was drawn to the rapidly moving cross belt, which carried it off to the side and dropped it into a hopper. The zinc-

ite and willemite, which differ appreciably in specific gravity, were then classified by jigs. Thus, some 250 years after the deposits were discovered, was a means devised by which the three main minerals in the ores could be separated from one another. Wetherill's process made it possible for the first time to put the willemite to use. The spelter made from it was found to be of high grade, and a plant for the production of slab zinc was thereupon erected in Newark.

All the troubles of the struggling zinc industry in New Jersey were not entirely attributable to difficulties encountered in trying to smelt the ores. In 1857, as a result of misconceptions as to the structure and composition of the ore bodies, litigation arose among the various companies holding interests in the area. The section in which the deposits lay had been divided and subdivided and passed from hand to hand throughout the years. As the holder of any single parcel could and often did grant up to four mineral rights—zinc, franklinite, iron, and surface—ownership of the area was probably the most complicated of any mining district in the world.

Colonel Fowler sowed the seeds for that litigation in 1848. Believing, like others of his time, that the Mine Hill deposit was made up of two abutting and parallel veins—one zinc and the other iron ore—he conveyed title to the Mine Hill zinc to The Sussex Zinc & Copper Mining & Manufacturing Company and rights to the franklinite and "other iron ores" to the Franklinite Mining Company. Law suits resulting from this granting of two separate and distinct titles to the same vein of ore, as well as from other causes, were carried to the highest courts of the land and did not cease until the participants formed one company some 40 years later. In 1897 The New Jersey Zinc Company, as it was finally named, acquired the stock of all the others working or holding interests in the Mine Hill and Sterling Hill deposits.

Consolidation permitted the mapping out of a long-range plan for the exploitation of the ore bodies as a unit and the construction of a smelter to take the place of several small, scattered plants. A site on the Lehigh River in Pennsylvania was selected for the purpose and named Palmerton after Stephen S. Palmer, then president of the company. It was near anthracite coal fields, close to the ore supply, and an excellent shipping point. Since that time the smelting facilities there have grown to two large plants that are operated by The New Jersey Zinc Company (of Pa.), a subsidiary.

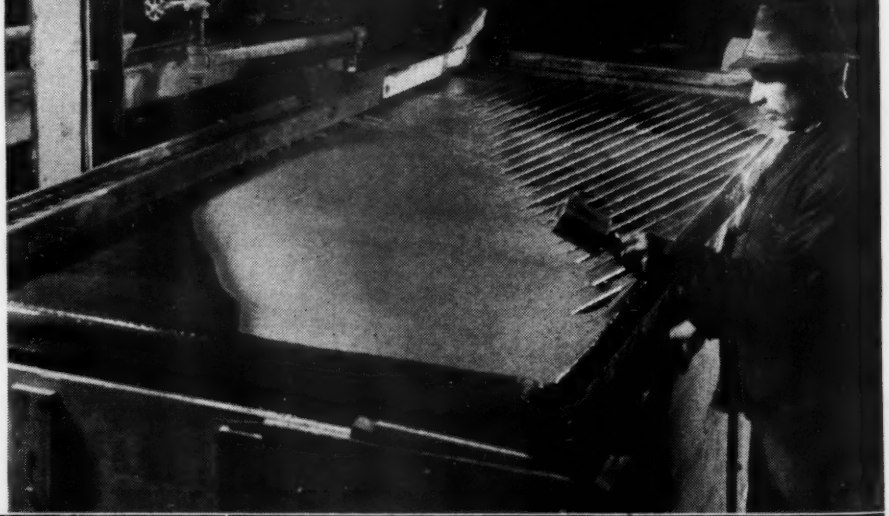
The methods by which ore is taken from the Franklin and Sterling mines today are far different from those practiced in the early days when brawny miners swung heavy hammers against hand-held rock drills and a shovel was the only loading machine known. Through the years, the deposits have seen practically every major advance in the art of mining: the development first of the steam and then of the air-powered rock drill; the invention of dynamite; the use of steam and electricity for operating hoists, scrapers, pumps, etc.; the introduction of electrified haulage systems, and so forth.

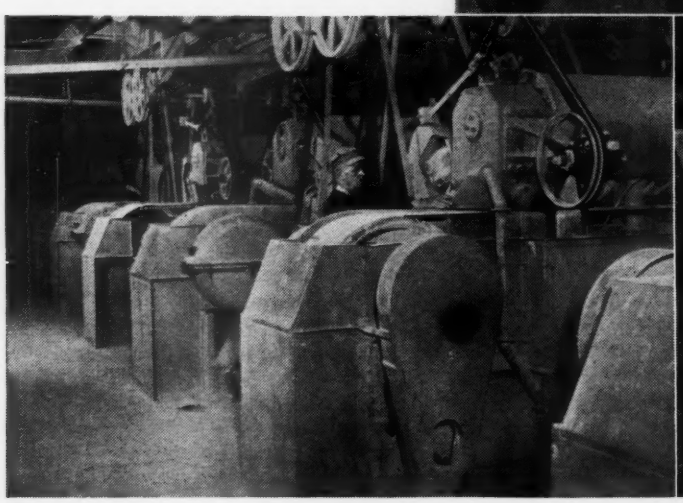
Now, the ore is brought down at the working faces with the aid of modern rock drills and other machines and is loaded by slushers or muckers into mine cars pulled by battery locomotives to chutes which dump it into electric trains for haulage to large bins. These transfer the material to 6-ton skips that hoist it from the mine through an inclined shaft at the rate of 3000 feet a minute. After separation and other treatment in a mill on the property, the bulk minerals are sent to Palmerton for smelting.

Zinc pigments and zinc metal made from the ores constitute raw materials which industry turns into countless prod-

SEPARATING THE MINERALS

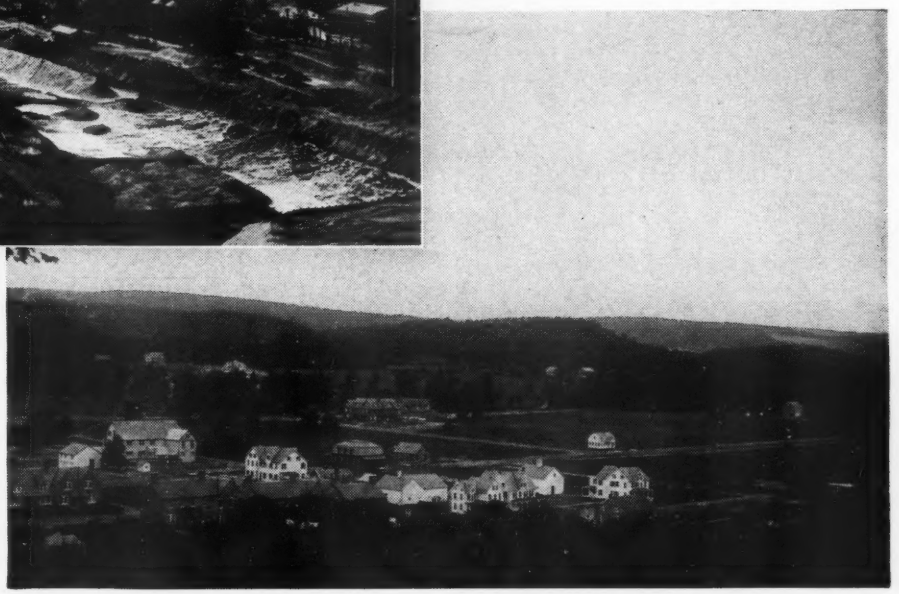
The unique character of the minerals defied efforts to separate them satisfactorily for nearly 250 years after the deposits were discovered. The main pieces of equipment now used for the purpose are shown here. From a belt conveying the crushed and dried ore, powerful electromagnets in magnetic separators (bottom-left) pick up the magnetic franklinite, which is then carried off on small cross belts. The willemite and zincite in the residue ore are next separated by jigs (bottom-right), after which the willemite is concentrated on vibrating tables (upper view). The operator is shown examining the table by the light of an arc lamp that causes the willemite to fluoresce.





WHERE ORES ARE SMELTED

In 1899, Palmerton was just a small cluster of houses in a sleepy valley (below). Contrast that scene with the recent picture at the left showing the East Plant where zinc oxide, paint pigments, luminescent pigments, sulphuric acid, metal powders, ferromanganese, and rolled zinc are made. The West Plant, not illustrated, turns out zinc oxide, slab zinc, and spiegeleisen.



ucts for every conceivable use in the home, the office, and the factory—in fact, it is practically impossible to look anywhere without seeing something fashioned wholly or in part of zinc. The paint manufacturer mixes zinc oxide with white lead and titanium pigments so he can package the latter in thinned form ready for application. White outside paints to which it has been added are not only whiter, more durable, and cleaner than they would otherwise be but retain their whiteness over a period of years because they continually flake off in tiny bits which carry soot and dirt along with them—a unique property known as controlled chalking. Lithopone, one of the newer zinc pigments, is used extensively as a white pigment in interior house paints.

In the rubber industry, zinc oxide helps to increase the activity of the organic compounds that serve to shorten the curing period. Because it reinforces the material against wear and tear and tends to prevent overheating, it is used in the manufacture of tires for passenger cars, trucks, and buses. It also finds application in many of the processes involved in making all sorts of synthetic- and natural-rubber products.

Zinc oxide has played an important part in the ceramic industry since 1860, when it was first used as an ingredient in glass. Mixed with pottery glaze, it slows down contraction of the hot liquid, thus causing it to cool at the same rate as the pottery and lessening its tendency to craze. Incorporated in enamels for coating cast or sheet iron, the oxide lowers their melting point and helps to prevent warping of the base metal. It also gives good color, gloss, and a durable finish to ceramic ware. By far the largest percentage of the zinc oxide consumed by the industry goes into the making of enamels for products such as bathroom equipment, kitchen sinks, ranges, and refrigerators.

Because it is soothing to the skin, is harmless, and has mild antiseptic qualities, zinc oxide is a very useful ingredient in cosmetics, and The New Jersey Zinc Company supplies a special pharmaceutical grade for the preparation of ointments, creams, and powders. In ointments it serves as a local sedative and protective agent, while zinc-oxide face powder not only covers well but is also said to absorb ultraviolet rays from the sun better than any other white pigment, thus acting as a sunburn preventive.

Pigments that glow in the dark are made from the zinc ores. They are of two kinds: phosphorescent and fluorescent. The former glow for an indefinite period after they have been energized by visible light (sunlight or ordinary electric light), while fluorescent pigments shine only when actually energized by certain invisible light rays such as ultraviolet—"black" light—present in the spectrum. Both are used in connection with plastics, paints, inks, paper, and textiles and enter into the manufacture of a long line of products such as directional signs, switch plates, dials for radios and automobiles, and a variety of things to point our way at night. They are also utilized to give toys, gifts, etc., glowing colors, as well as to provide decorative advertising effects.

Coating iron or steel with zinc protects it against rust. Woven-wire fencing and strip-steel products such as rolled metal containers, radio chassis, electrical cable, and hardware are among the many commodities that are galvanized to offset corrosion. Just how important that industry is today is brought out by the fact that, on a volume basis, it is the largest industrial consumer of zinc.

Die-casting has become one of the leading high-speed production methods of our day largely because of the availability of zinc alloys. By this process, molten metal under pressure is forced into steel dies. Its chief advantage lies in the fact that it permits reproducing with accuracy complex shapes that would be hard to make by other means. An alloy is needed for this purpose that will flow readily to all corners of the die, set quickly, and possess strength and hardness.

The New Jersey Zinc Company puts out two special products for die-casting: Zamak, an alloy of high-purity zinc, aluminum, and copper; and Horse Head Special slab zinc, which is more than 99.99 percent pure. These serve to turn out an endless list of articles in everyday use in industry and in the home. The fittings on that gleaming new refrigerator or washing machine are zinc die castings plated with chrome. The grillwork on the front of that shiny new automobile is similarly made, and its carburetor, fuel pump, and other engine and body parts are cast in the same manner, as are parts of lighting fixtures, radios, tools, elec-

trical appliances, vending machines, typewriters, and business machines, to mention only a few.

The brass industry also is an outlet for slab zinc. An alloy of copper and zinc, the metal generally contains about 30 percent zinc and serves to form a wide variety of products including household hardware, plumbing fixtures, and rods and tubes for industrial application. For such purposes as deep drawing cartridge cases, for example, it is necessary to use high-purity zinc to give the brass the required ductility and formability. The greatest single demand for brass containing zinc of this quality is in the manufacture of condenser tubes required in generating steam, in refining oil, and in similar industrial processes.

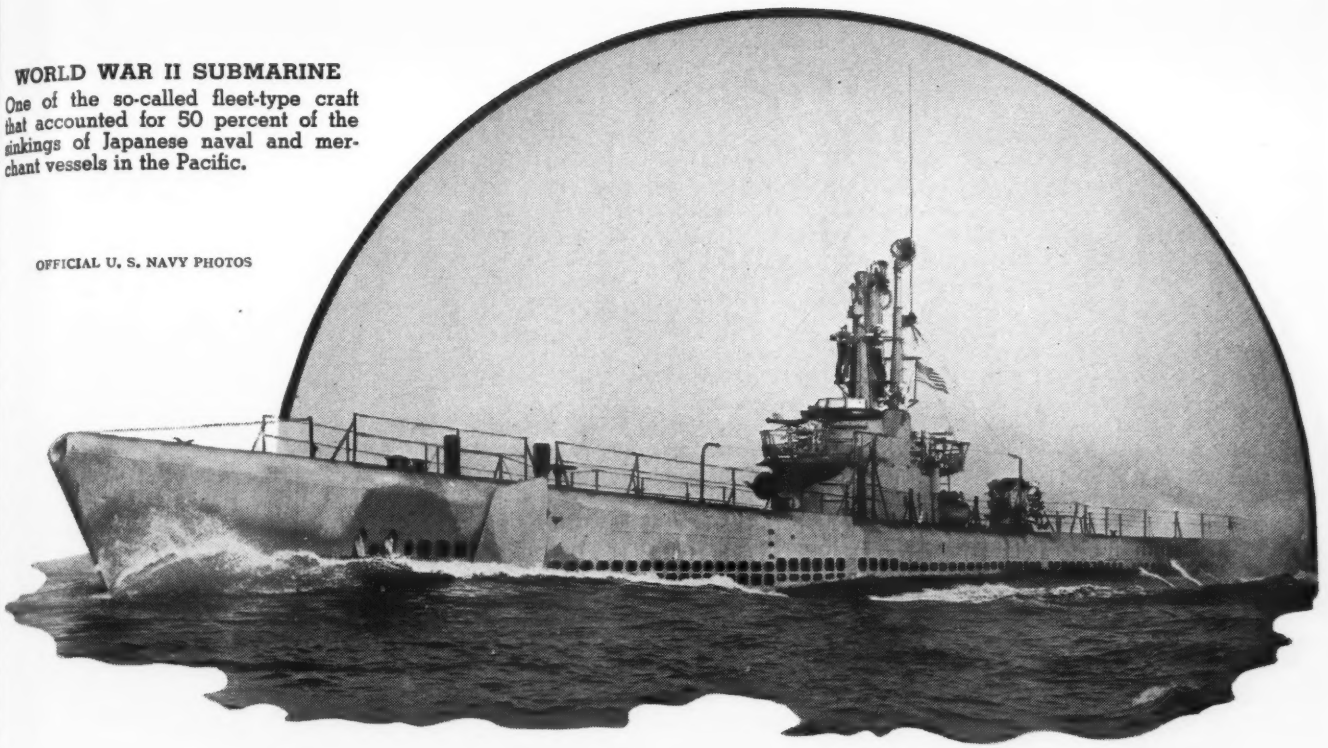
Rolled zinc comes in the form of strips, sheets, and plates and there is an extensive demand for it in the metal-fabrication field. The largest use to which it is put is in the making of dry-cell battery cans where it serves both as container and as active chemical. Other products include weather stripping, molding, roofing and siding, screen frames, eyelets and grommets, and many other things turned out by spinning, drawing, and stamping.

Spiegeleisen is one of the oldest and most adaptable alloys known to the steel industry. Composed of iron and manganese, it is used in the manufacture of basic open-hearth steel, electric-furnace steel, and Bessemer steel, as well as gray and malleable iron in the cupola or air furnace. Its primary purpose is to cleanse steel of impurities during the refining period, but frequently it is added to the initial furnace charge to increase the amount of manganese in the finished product.

The New Jersey deposits are more than just an oddity of nature. Their size, richness, and type of mineralization alone are enough to set them in a class by themselves. But more important than these characteristics is the part they played in the economic development of our country. Every zinc ore contains some contaminants, and only in the past few decades has it been possible through metallurgical advance to do more than crudely control the quality of the zinc obtained from a given ore. Because those from the Franklin-Sterling mines contain far less impurities than other zinc ores, the metal produced from them in the early days had unusual properties. That enabled the United States to forge ahead in several important industries and, by so doing, affected the lives of all Americans. Because of this, the two deposits in northern New Jersey that yield the peculiar red, green, and black zinc ore have earned a place in our nation's history.

ZINC PRODUCTS

The ores sent to the smelting plants emerge as a number of different industrial raw materials. The view at the upper-left shows a furnace that turns out zinc oxide for use in the making of decorative and protective finishes. Rolling mills, pictured at the lower-right, produce zinc strips, sheets, and plates that are converted into battery cans, weatherstripping, molding, fruit-jar tops, eyelets, and protective plates for ships' hulls. Slab zinc (lower-left) serves to coat (galvanize) iron and steel to prevent rusting. High-purity slab zinc is produced in specially designed furnaces and shipped to die-casting plants that turn out castings for fuel pumps, hardware, and radiator grills of automobiles, as well as for refrigerators, washing machines, business machines, small tools, and numerous other things.



WORLD WAR II SUBMARINE
One of the so-called fleet-type craft that accounted for 50 percent of the sinkings of Japanese naval and merchant vessels in the Pacific.

OFFICIAL U. S. NAVY PHOTOS

Air Power on American Submarines

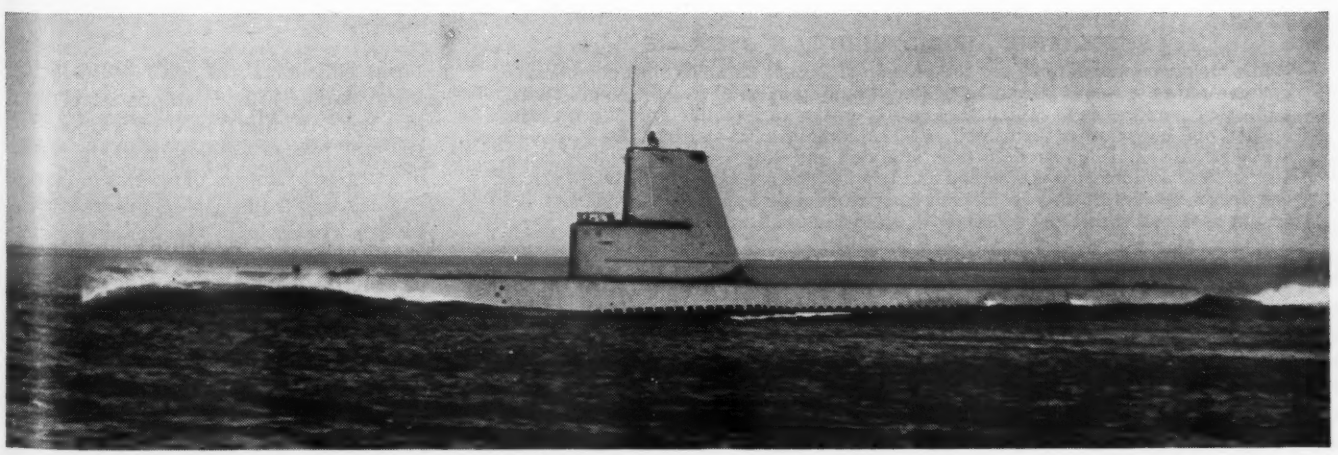
Five Distribution Systems Provide Various Pressures to Perform Vital Services

Howard S. Dewey

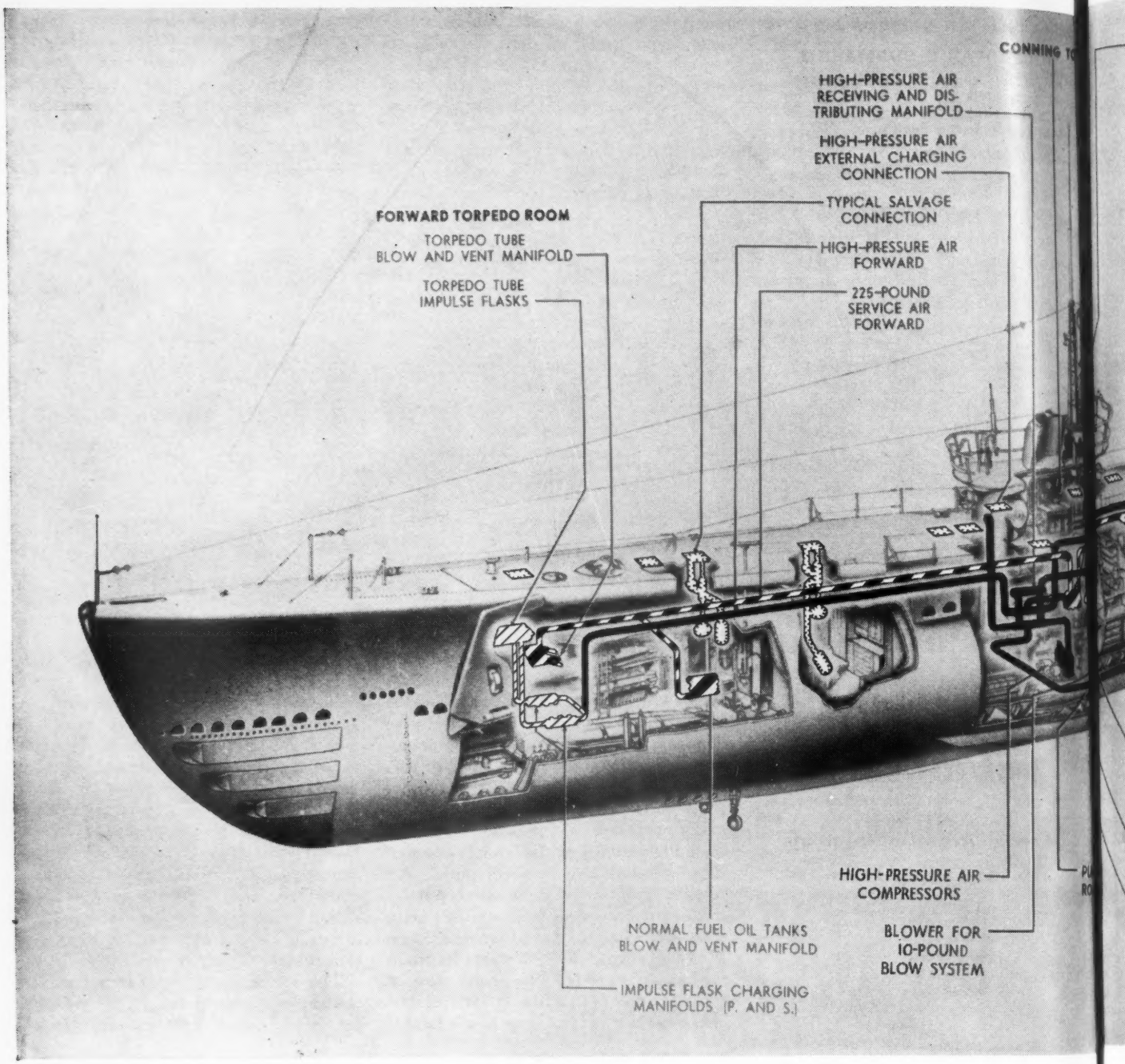
ON OUR first submarines, compressed air was used primarily for forcing water from the ballast tanks when it was desired to surface the craft. Since then, with each successive change in design, the importance of compressed air has increased until it performs a multitude of duties. Its functions range from controlling virtually every operation in connection with diving and surfacing to the ignoble chore of blowing waste from sanitary tanks. Air pressure maintained in an air-accumulator flask operates the submersible's main hydraulic system. Air power discharges its lethal torpedoes and starts its main propulsion engines. To make sure of hull tightness before diving, compressed air serves to "put pressure in the boat."

Air can be compressed easily aboard a submarine because only a relatively small plant and comparatively simple equipment are required for the purpose. It can be stored in small steel receivers and is always ready for use. The precise action desired can be obtained from it by varying the pressure, and as air has a cushioning effect on working mechanisms wear and tear on them is reduced. It consumes no valuable materials and can be readily piped to any part of the craft. Air once stored can be applied without further expenditure of energy—in fact, is a source of power for the operation of other equipment.

There are five separate air systems on the modern underwater boat: the 3000-psi. high-pressure system, the 600-psi.



POSTWAR SUBMARINE
Compare the seal-slick lines of the conning tower with the cluttered superstructure of the boat shown at the top of the page. This new type is known as the "guppy-snork," a term that designates streamlined fleet-type subs that are equipped with "snorkels" and new, more powerful batteries. The snorkel is a slender air-intake tube that projects above the surface while the vessel is running underwater and enables the diesel engines to keep functioning. Snorkel is derived from the German "schnorchel," which means breathing tube.


CONNING TO
HIGH-PRESSURE AIR RECEIVING AND DISTRIBUTING MANIFOLD
HIGH-PRESSURE AIR EXTERNAL CHARGING CONNECTION
TYPICAL SALVAGE CONNECTION
HIGH-PRESSURE AIR FORWARD
225-POUND SERVICE AIR FORWARD
FORWARD TORPEDO ROOM
TORPEDO TUBE BLOW AND VENT MANIFOLD
TORPEDO TUBE IMPULSE FLASKS
HIGH-PRESSURE AIR COMPRESSORS
NORMAL FUEL OIL TANKS BLOW AND VENT MANIFOLD
BLOWER FOR 10-POUND BLOW SYSTEM
IMPULSE FLASK CHARGING MANIFOLDS (P. AND S.)

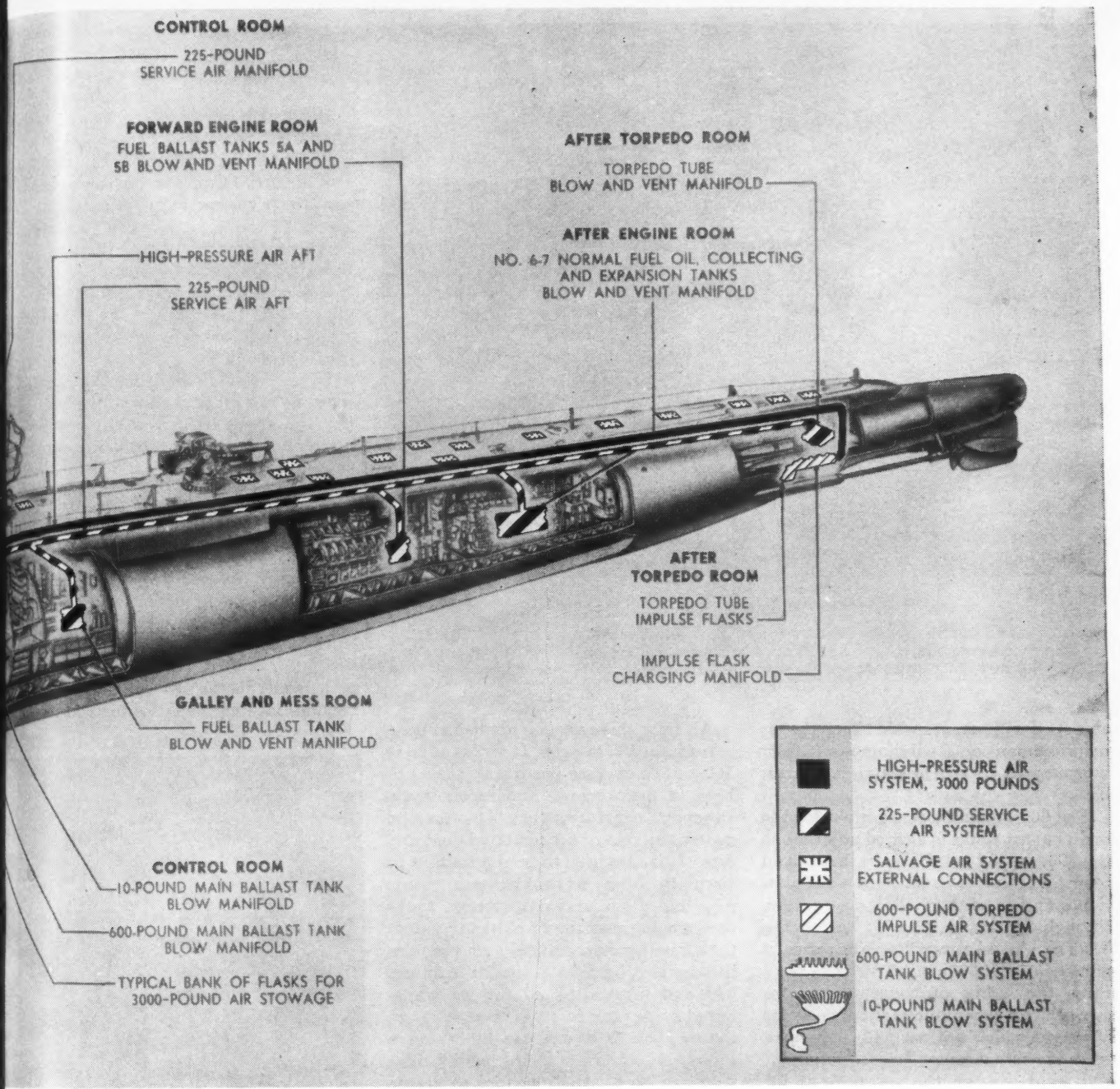
SUBMARINE AIR-DISTRIBUTION SYSTEMS

While the boat is submerged, the compressed-air supply for all its different pressure systems comes from storage tanks that are charged at 3000 psi. by motor-driven, multistage compressors. When the craft is on the surface, the conning tower is opened and blowers that furnish air at 10 psi. pressure are started. The 10-pound air takes care of all the services then operated and thus conserves high-pressure air. In case a submarine is disabled and lying on the sea bottom, a salvage vessel can introduce compressed air to each compartment through external connections on the deck and thus blow out water to bring the craft to the surface.

blowing system for the main ballast tanks, the 225-psi. "ship's-service air system," the 10-psi. main-ballast-tank blowing system, and the salvage air system. All are normally supplied with air from a compressor plant located in the pump room underneath the control-room deck. The machine currently being furnished for American submarines is a direct-connected, motor-driven unit that has a capacity of 20 cubic feet per hour at a discharge pressure of 3000 psi., which is the equivalent in free or atmospheric air of 4080 cubic feet per hour or 68 cfm. For some purposes the air is used at this final pressure of 3000 psi.; for others it is reduced by regulating valves and fed to the several lower-pressure systems just enumerated. Distribution and reduction call for an extensive network of connected manifolds, piping, and valves.

The reason for selecting 3000 psi. as the maximum air pressure on American submersibles has been outlined by Commander J.R.Z. Reynolds, U.S.N., Material Officer on the staff of Rear Admiral James Fife, Commander of Submarines, Atlantic Fleet. A graduate of the U.S. Naval Academy and the holder of a degree of master of science in marine engineering from Massachusetts Institute of Technology, Commander Reynolds has specialized in submarine engineering for the past twenty years.

"Torpedoes," he states, "must be charged with 2800 pounds of air in order to obtain maximum running range. This apparently set the criterion for 3000-pound air pressure on pre-World War I submarines, a practice that has been consistently adhered to ever since. A pressure of 4500 pounds has been suggested as being more satisfactory from the viewpoint of economy and efficiency of operation. One objection to this is that it would create extra problems in the


CONTROL ROOM
225-POUND SERVICE AIR MANIFOLD
FORWARD ENGINE ROOM
FUEL BALLAST TANKS 5A AND 5B BLOW AND VENT MANIFOLD
HIGH-PRESSURE AIR AFT
225-POUND SERVICE AIR AFT
AFTER TORPEDO ROOM
TORPEDO TUBE BLOW AND VENT MANIFOLD
AFTER ENGINE ROOM
NO. 6-7 NORMAL FUEL OIL, COLLECTING AND EXPANSION TANKS BLOW AND VENT MANIFOLD
AFTER TORPEDO ROOM
TORPEDO TUBE IMPULSE FLASKS
IMPULSE FLASK CHARGING MANIFOLD
GALLEY AND MESS ROOM
FUEL BALLAST TANK BLOW AND VENT MANIFOLD
CONTROL ROOM
10-POUND MAIN BALLAST TANK BLOW MANIFOLD
600-POUND MAIN BALLAST TANK BLOW MANIFOLD
TYPICAL BANK OF FLASKS FOR 3000-POUND AIR STOWAGE
HIGH-PRESSURE AIR SYSTEM, 3000 POUNDS
225-POUND SERVICE AIR SYSTEM
SALVAGE AIR SYSTEM EXTERNAL CONNECTIONS
600-POUND TORPEDO IMPULSE AIR SYSTEM
600-POUND MAIN BALLAST TANK BLOW SYSTEM
10-POUND MAIN BALLAST TANK BLOW SYSTEM

maintenance of compressors and air-distribution systems. The work load would increase and reliability would decrease. Reliability is an important factor on submarines," he concludes, "for providence grants few second chances to the submariner." The Germans held to the 3000-pound standard in their most advanced boats, although the British disdain this pressure and use 4000 pounds instead.

Following its compression, the air is distributed through a receiving manifold to air banks, of which there are five with a combined capacity of approximately 580 cubic feet. Four of them are each composed of seven connected flasks or bottles, which are similar in shape to welders' acetylene flasks. The fifth is an 8-bottle emergency bank which normally serves only when one or more of the others are empty or damaged. To conserve space, the former are located in the ballast tanks, which bulge out from the pressure hull like blisters on a finger, while the emergency bank is inside the protective pressure hull.

Once the banks are charged, the procedure can be reversed—air can be taken from them through the receiving manifold and thence to two distribution manifolds. From the latter it can be routed to the forward and after torpedo rooms or to the main propulsion-engine starting fasks, where it is reduced in pressure. In the torpedo rooms the high-pressure air can be used to charge the "fish" or directed to the torpedo impulse flasks. Air from the latter, which are miniature flasks, serves to eject or "fire" the torpedoes from their tubes.

The receiving and distribution manifolds are the key manifolds of the high-pressure system and are arranged horizontally one above another in the control room. In addition to bank stop valves, the receiving manifold is provided with an external charging connection with a line running topside so that high-pressure air can be obtained from an outside source. On the distribution manifolds there are stop valves for blowing certain of the tanks that are designed to resist that pressure. Another connection charges the hydraulic-accumulator flask which maintains a steady pressure on the reservoir of oil on the piston which, in turn, provides the hydraulic system with a volume of oil at the desired pressures. This piston operates in much the same manner as the hydraulic grease rack at your neighborhood service station. The three manifolds are further

STANDING BY TO BLOW MAIN BALLAST TANKS

Control equipment of distribution air manifolds, with gauges showing pressures in the various storage tanks. Regulator valves for admitting air to the ballast tanks are located at the upper right.

equipped with gauges which keep the air manifoldman or "windjammer" fully informed as to the pressure in the air banks.

The 600-pound blow manifold for the main ballast tanks is located adjacent to the 3000-pound manifolds in the control room and receives its air from a distribution manifold of the 3000-pound system through one of two reducing valves, the other serving as a standby. The primary purpose of the 600-pound air is to blow those tanks free of water when submerged. This manifold is simply a series of valves which are normally left open when the submarine is "rigged for dive" and secured when the vessel "rigs for surface" and returns to port, each valve being a stop to its own ballast tank. The master or "hammer" valve which controls the amount of air which is allowed to flow from the high-pressure to the 600-pound manifold is not an automatic reducer. Air pressure is manually controlled by the volume admitted to the 600-pound system, which is equipped with relief valves and is tested hydrostatically to 1000 psi.

The 225-pound or "ship's-service" system is the submarine's utility air system. It controls or furnishes power for more than 100 operations from bow to stern and is more extensively used than any of the others. A maze of piping, valves, pressure reducers, and connections, it spreads throughout the various compartments of the boat. The center of this complex, spidery network is the manifold which, like the 600- and 3000-pound manifolds, is in the control room.

Air from this system is applied at pressures from 225 to 8 psi. It serves at 80 to 100 psi. to operate pneumatic tools utilized in maintenance and repair work. Purged of moisture, it blows motors and generators free of accumulated dust and dirt. It is also used instead of pumps to circulate fresh water, pressure being maintained on enclosed storage tanks through the medium of reducing valves that function automatically and require little attention. In a similar manner, fuel and lubricating oil can be transferred from tank to tank. Sea water in the variable ballast tanks by which a submarine is given a fine equilibrium trim can be blown from fore to aft or vice versa in whatever quantity may be desired.

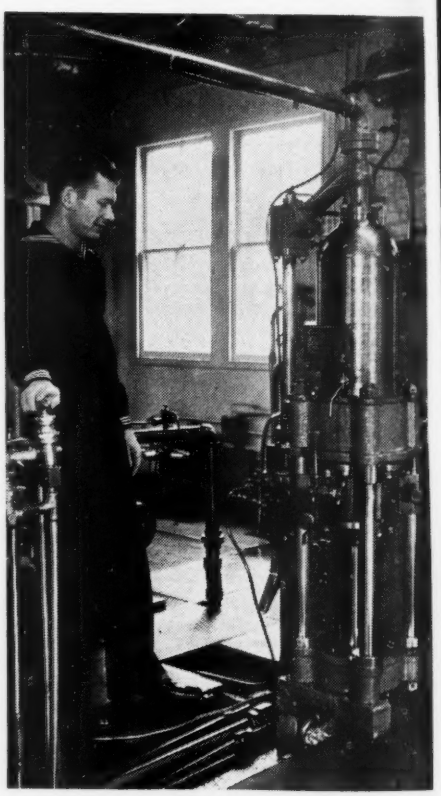
Wherever possible, service air substitutes for pumps, the advantage being a reduction in machinery and electrical-power consumption. Its most attractive asset from the submariner's point of view is that it is quiet in its operation, which is highly desirable when trying to blow water from one tank to another and yet evade stalking destroyers. The whistle and siren, too, are actuated by air from this system.

Although high-pressure air is a quick and effective medium for blowing ballast tanks, economy in its use must be practiced. For that reason a low-pressure blower is carried on submersibles to complete the evolution of "blowing up." Once the boat has surfaced, the conning-tower hatch, which is the highest point on the pressure hull, is opened and the blowers are cut in. They are located in the pump room with a manifold directly above in the control room.

The blowers furnish air at a pressure of about 10 psi. to the manifold which, in turn, distributes it to the ballast tanks that are to be blown. This complete and independent air system is the simplest one aboard. Controls on the manifold can direct the air to any single tank or group of tanks. It is also possible to compensate for any "list" the ship may have by blowing to the port or starboard side of split ballast tanks. The Germans eliminated this system by diverting main-engine exhaust gases into the tanks.

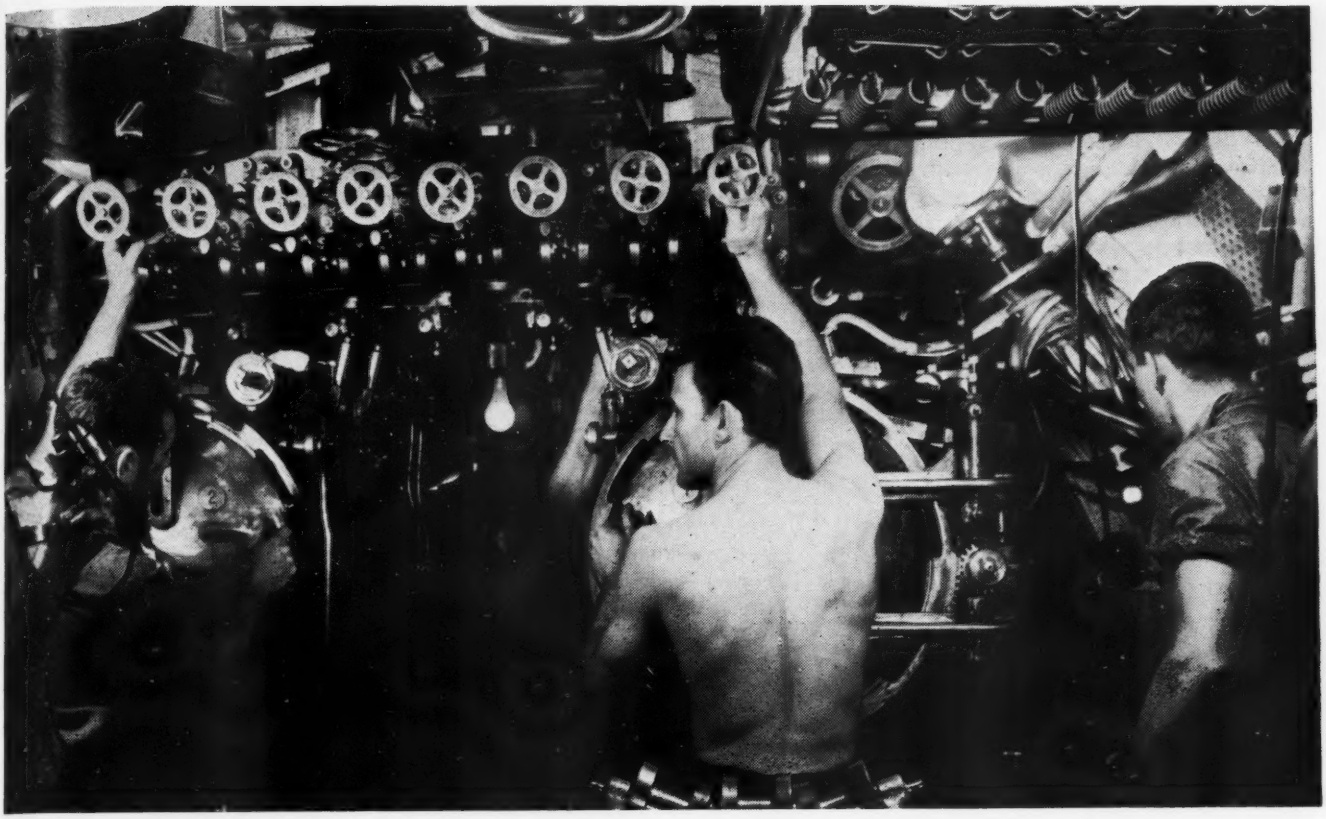
Being concentrated in the control room at one station, the controls of all the air systems are manned by one crewman. During diving or surfacing, it takes the agility of a 16-year-old boy to handle them all in quick succession. From a maintenance angle they present an even greater problem. The frustrated auxiliaryman, who must crawl into this maze of piping in order to fix a leaky connection, needs a pointed head and three extra hands.

The final air network, which is seldom used but religiously tested and operated periodically, is the salvage air system. It includes internal facilities for the use of



HYDRAULIC ACCUMULATOR

A crewman at the Submarine Base in New London, Conn., familiarizes himself with an essential piece of submarine apparatus. His hand is on a valve that controls the admission of compressed air behind a piston that puts pressure on fluid in a steel bottle. The pressurized fluid is piped around the boat for operating various mechanisms.



READY TO FIRE TORPEDO

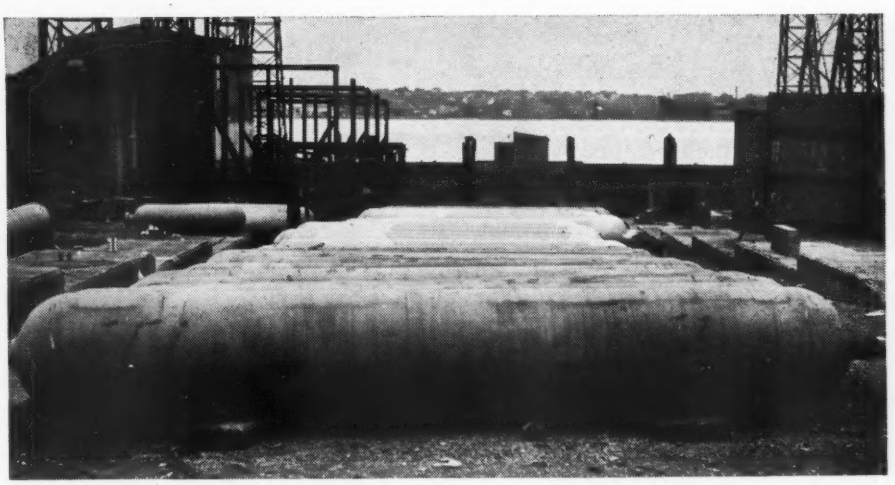
Scene in the forward torpedo room of a U. S. submarine with its welter of control mechanisms. The bare-backed crewman has one hand on a quick-opening valve lever, ready for the signal to fire a torpedo or "fish" from its tube with air at 2800 psi.

the crew and external connections for outside agencies such as divers. In the case of the former there is a branch line in each compartment from the 225-pound air system, with a valve that can be actuated from an adjoining compartment. This allows crewmen to blow water out of one that is flooded while remaining safe and dry in the compartment located immediately aft or forward of it.

The external system is more complicated in its details and used in the event a submarine is lying on the bottom disabled, with its crew either dead or unable to surface her. Each ballast tank is provided with a salvage line and valve which can be operated from the topside deck. In service, an air hose from a rescue vessel is connected to the line by a diver, the valve is opened, and air from the salvage craft is then forced successively into the stricken submarine's ballast tanks. Each can be blown dry in this manner and the boat returned to the surface.

Each compartment has one salvage valve and line located at each end. These, too, are accessible from the deck. One, termed the high-connection valve, supplies air near the high point of the hull; the other, called the low-connection valve, is equipped with a pipe extending to the low point in the compartment. To blow it dry, both connections are opened. Compressed air enters the compartment through a hose from the rescue vessel, while the water is forced out and overboard through the low connection. All the topside lines and valve fittings for both compartments and tanks are marked by individual plates bolted to the deck nearby. The plates are affixed with round-head screws and lugs so that a diver can readily identify each of the compartments and tanks simply by touch.

Atomic power being what it is, any prediction as to the future of submarine air systems is a precarious thing. It is generally believed, however, that they are high-pressure bound. This statement is made in view of the fact that designers dream of a vessel plunging 1000 or more feet into the ocean. Air pressures must, willy-nilly, climb proportionally higher with every added foot of water the submarine will be built to penetrate. Air lines with their thick walls will carry pressures up to 6000 pounds. Regardless of inherent faults that attend higher pressures, they would give the underwater boat a greater volume of indispensable compressed air.



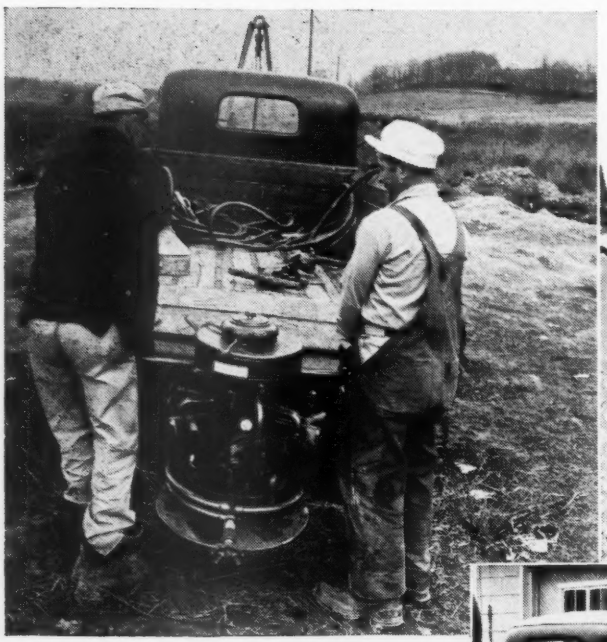
HIGH-PRESSURE AIR FLASKS

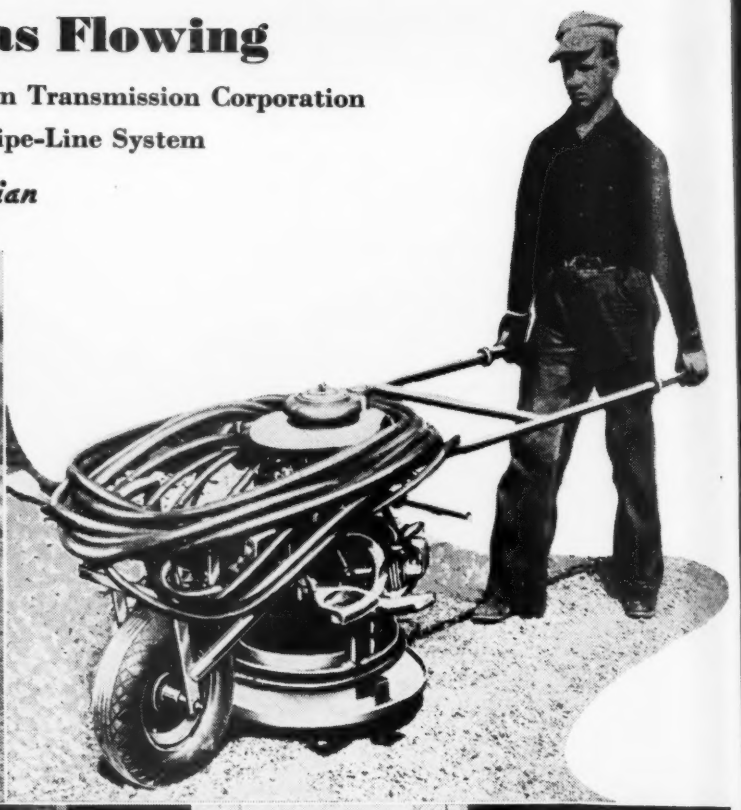
Steel cylinders for the storage of air shown on building ways awaiting painting and final coating with a plastic before being placed aboard a submarine. The ones in the foreground are 18 inches in diameter and 11 feet 4 inches long. The flasks are arranged in banks normally of seven each.

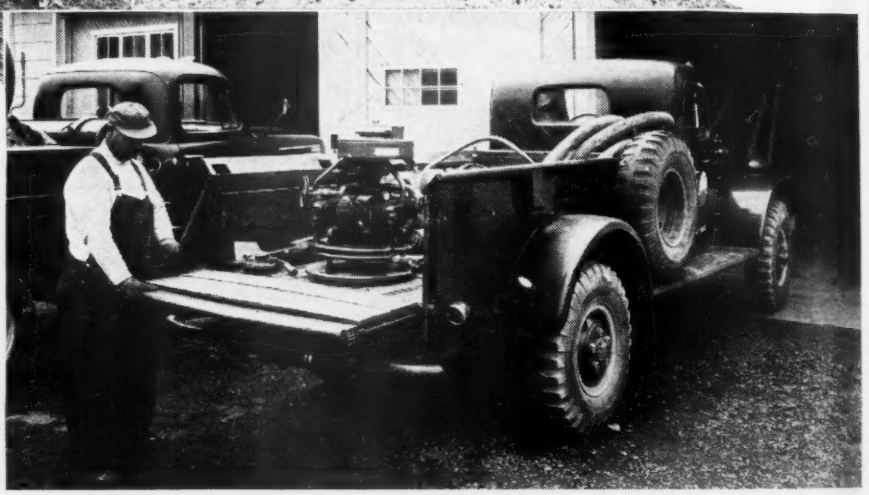
Keeping the Gas Flowing

Air-Operated Tools Help Texas Eastern Transmission Corporation Maintain Its Extensive Pipe-Line System

C. H. Vivian







GETTING AIR POWER TO THE JOB

The 3R-30 compressor was developed for railroad track work and has only recently been introduced into the construction field. Its radial design, with three gasoline-engine power cylinders and three compression cylinders alternated at 60-degree intervals, results in smooth conversion of engine torque into air power without the use of a heavy flywheel. Extreme compactness and light weight make the unit easy to transport to off-road locations where much pipe-line work is done. Although it is small, the machine is carefully and precisely built for heavy duty and compares well in dependability with larger compressors. At Texas Eastern maintenance stations the 3R-30 is ordinarily hauled about in a Dodge Power Wagon (lower picture), along with complementary tools, hose lines, etc. Upon arrival at the working site (upper-left) a lifting bar is slipped into place and two men unload the machine and carry it to wherever it is needed. A pneumatic-tired wheelbarrow mounting (upper-right), which can be quickly affixed, enables one man to push the compressor to points the truck cannot reach.

THE recent pronounced increase in natural-gas pipe lines in America has brought with it steadily mounting maintenance burdens. The problems arise not only from the growing mileage of transmission lines in service but also from the trend towards larger-diameter pipe and higher operating pressures. Trunk lines of 20-, 24-, and even 30-inch diameter are becoming common rather than extraordinary, and pressures of 500 psi. and higher are no longer unusual. Some systems are already operating in the 750-psi. range; and engineers, without so much as lifting their eyebrows, talk of going to 900 psi. in the near future.

A natural-gas pipe line, like a railroad, is a public-service enterprise. It carries a commodity that is vital to the comfort and economic life of entire cities, even states. An interruption in service can paralyze the normal activities of thousands of persons. In the interest of public convenience and necessity, it is therefore incumbent upon transmission companies to exert every effort to maintain scheduled deliveries. They themselves have a selfish interest in doing this, for crippled or dead lines bring in no revenue.

The nation has long had extensive networks of oil pipe lines, but the need of keeping them functioning is not so urgent as it is in the case of the newer gas lines. Petroleum or its products go from fields to refineries or distributing depots —not directly to consumers. Moreover, temporary supplies can be stored to tide over periods of pipe-line shutdown. Natural gas, on the other hand, is a household and industrial utility. It can't be accumulated in appreciable quantities near points of use. If the pipe line ceases to deliver it, even for a few minutes, consumers begin to suffer. Obviously then, the responsibility of maintaining continuous service is a heavy one.

Natural-gas pipe lines sprawl across the country for hundreds of miles, most of them obtaining their supply in the Southwest. Although the pipe, even in the larger sizes, has walls less than half an inch thick, it is sufficiently strong to withstand the pressures involved, thanks to ever-advancing steel-mill metallurgy and manufacturing technique. High-

pressure pipe now laid is of welded-seam or of seamless-steel construction, and it undergoes rigorous testing and meticulous inspection before it is approved for service. Sections of transportable length are joined in the field by welding, and despite the unbelievable speed with which they are laid they are put together with extreme care and precision.

Before being lowered into the trench, the pipe is scrupulously cleaned, then coated and wrapped to shield it from ordinary corrosion. To thwart corrosion caused by electrolytic action—by stray currents picked up from the ground, opposing currents are induced by cathodic protection systems. Account is even taken of the effects of seasonal and diurnal temperature changes, the line being strung in a sinuous fashion to permit the forces of expansion and contraction to exert themselves with a minimum of harm. Actually, a large line does considerable writhing in its trench, shortening itself in winter and lengthening in summer. Where it crosses a hill it tends to creep down slope when warm, and, if not properly constructed, ensuing contraction during the following cold season may put the crest section under great pulling strain.

Numerous interstate transmission lines represent expenditures of more than 100 million dollars each, and others, calling for equally large outlays, are being constructed or planned. Since the earnings on the investment are adversely affected by service interruptions, it is sound business to make adequate provisions for maintenance, aside from the paramount consideration of fulfilling obligations to customers. As in the case of a railroad, maintenance crews are stationed all along the line, with the distances between bases short enough to permit reaching all intervening points quickly and conveniently.

The crews cover a wide range of activities. They may be called upon to cope with anything from a washout caused by a flash flood along the right of way to repairing a break in the line under stress of getting it back in operation without wasting a minute. Most of their day-to-day jobs are of such a routine nature as changing valves or piping around compressor stations, tapping lines for making additional connections, or installing new equipment of one sort or another. Nevertheless, they must be prepared to meet any emergency that may arise along the lines or at the stations.

To perform their widely varying tasks effectively and quickly, the crews are turning more and more to power equipment. And, as is true of all maintenance work, this includes a liberal use of air-operated tools, which are particularly well suited for natural-gas companies because they present no hazard of fire or explosion. Air-powered tools, especially impact wrenches and drills, have long been regularly employed for overhaul and repair jobs in the compressor stations, and now they are being used increasingly on the lines themselves.

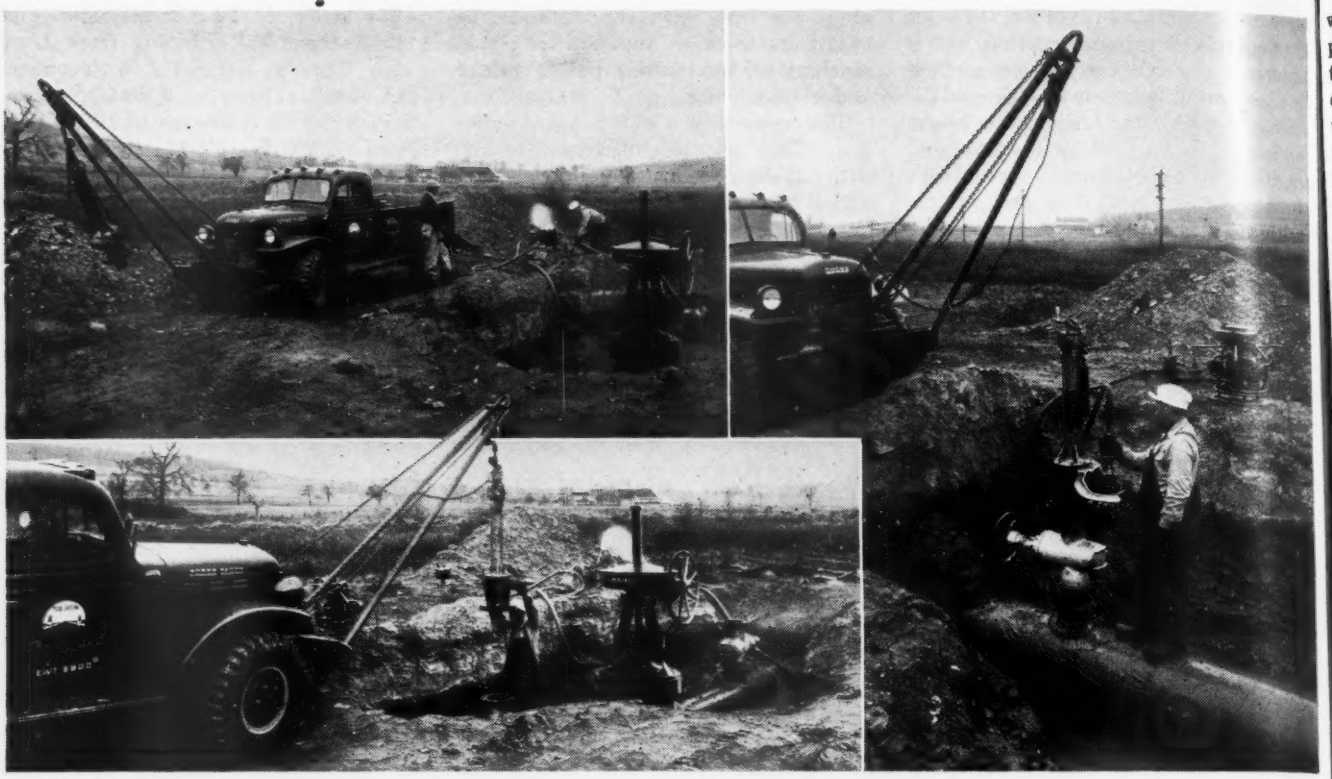
Accompanying illustrations show typical applications of some of the compressed-air equipment recently put in service by Texas Eastern Transmission Corporation, which purchased and converted to gas transmission the Big Inch and Little Big Inch lines built by the Government in 1942-43 to move crude oil and gasoline from Texas to the Atlantic seaboard. The Big Inch consists of 1254 miles of 24-inch-diameter pipe, mainly seamless, running from Longview, Tex., to Eagle, Pa., with connecting smaller lines to Philadelphia and Staten Island (Borough of Richmond), New York City. The Little Big Inch is a 20-inch line, mainly electric welded, that extends 1479 miles from Beaumont, Tex., to Linden, N. J. Both have gathering networks at their western extremities. From Little Rock, Ark., to Eagle the two main arteries run side by side over the same right of way.

For operating purposes, the line is divided into four sections. Division No. 1 runs from Longview on the 24-inch and Homer, La., on the 20-inch to the Mississippi River; No. 2 from the Mississippi to the Ohio; No. 3 from the Ohio to Philadelphia and New York; and No. 4, the latest one, from Homer south to Beaumont and Baytown, Tex. Every division has two maintenance headquarters under each of which work five or more crews based at strategic points. All told, there are 32 crews—one every 50 miles—of four men in the small units, or an average of six per crew. A foreman is in charge of each gang. The number of workers varies, usually being greatest at maintenance headquarters.

Typical of the organization throughout the system is the setup in the section visited by the writer. It covers the eastern part of Division No. 3 and extends from a point west of Chambersburg, Pa., to New York and Philadelphia. Headquarters are at Station 25 located about midway at Eagle, on which a crew of seven is based. There are crews of four each at Chambersburg and Marietta, Pa., and one of five at Linden. Including a maintenance foreman at Eagle

OPERATING A PAVING BREAKER

In many instances the compressor remains on the truck while it supplies power for such operations as tamping backfill in a trench with a PB-6 paving breaker equipped with a tamping pad (left). Where the machine is unloaded, it need not be leveled to function smoothly but can be put down on uneven ground. It is shown at the right powering a spade-equipped paving breaker being used to loosen earth in making an excavation along a pipe line.



TAPPING A LINE UNDER PRESSURE

These pictures show a 20-inch line being tapped for the installation of a blow-off connection while gas under 400 psi. pressure continues to pass through it. The crew rides to the job in a Dodge Power Wagon, which also carries the 3R-30 compressor and accessory equipment in the truck body and a Mueller tapping machine suspended from gin poles on the front. If, upon arrival at the job, (upper-left) it is found that a previously made excavation has filled with water it is pumped out in a few minutes with a Homelite pump driven by a gasoline engine. Next (lower-left) the Power Wagon is run to the edge of the excavation and the tapping machine lowered onto the flange of a valve that has been welded on top of the pipe line. The tapping machine is bolted securely to the flange, its air motor put in place, and the tap is made (right) with power delivered by the 3R-30 compressor. Because the motor does not require the full 80 psi. pressure at which the air is discharged, a Chaplin-Fulton regulator is interposed in the delivery line to reduce the pressure, as desired. The valve is opened while the tap is being made, then closed and the machine removed. A blow-off stack about 6 feet high was subsequently bolted to the valve flange and provides a means of venting the line whenever it becomes necessary to take that particular section out of service.

in charge of all four crews, the total manpower is 21.

To increase the efficiency of its maintenance work, Texas Eastern recently bought the following equipment from Ingersoll-Rand Company: Two 105-cfm. trailer-mounted portable air compressors; seven 3R-30 portable compressors with wheelbarrow mountings; seven PB-6 paving breakers and a complement of steels for each; twenty-one No. 534 and twenty-one No. 577 impact wrenches with accessory bits and sockets; and the necessary hose and couplings to deliver air to the tools. This equipment is distributed among the various crews. As the impact wrenches are the most used of the tools, every crew has one of each size.

The compressors are spaced along the line at an average interval of 200 miles, and because they are mobile all are at the disposal of several crews based on opposing sides of the points at which the machines are stationed. As a matter of fact, there is considerable trading back and forth of the tools other than the impact wrenches, the aim being to schedule the work of the crews so that all the equipment will be kept busy a good part of the time. Several chipping hammers and Multi-Vane drills have been added since the initial purchase was made, and these, too, are available for use by any of the crews within reasonable driving distance of their bases.

One of the principal reasons for buying the equipment was to have it at hand in case of emergencies anywhere along the line. The crews talk about them with their fingers crossed, so to speak, and hope they won't happen. Actually, though comparatively rare, they do occur, and the better the provisions to cope with them, the sooner normal service and, incidentally, normal earning power will be restored. It goes without saying that an emergency calls out at least the two crews stationed nearest it and, if serious, those farther away. All the tools and compressors that may be required are likewise concentrated at the site, and the crews relieve one another so as to make the repairs without a halt until they are completed. In extreme cases it may take more than 48 hours to restore service. By saving time on these emergency jobs the equipment pays for itself in short order. Meanwhile, it is available for routine maintenance, and there, too, it helps to get the work done faster than was previously possible.

Small leaks in a line are fixed immediately. If they are promptly detected and taken care of the repairs are usually of a minor nature. To spot these tell-tale leaks, Texas Eastern has its line patrolled twice a week by airplane, under contract. It's a one-man operation, conducted by a flier who lives in Monroe, La. He not only covers the system thoroughly but also has time on each eastern trip to go over some other natural-gas lines in the same general area. Because natural gas kills grass with which it comes in contact, a skilled observer, flying at a proper height, can locate even a relatively small leak by the surface discoloration it causes.

Thus far, the equipment at Eagle has been called into emergency service only once. That was last December, when a break occurred in one of the two 20-inch lines between Eagle and Station No. 26 at Lambertville, N. J. At the point of the failure the lines are 17 feet underground, this unusual depth being attributable to the fact that they pass under railroad tracks just before entering a hill As the gas was under 418 psi. pressure, that

which escaped expanded greatly and produced a refrigerating effect that froze the ground above it. Because of this circumstance, and because the trench in which the pipe was laid had been backfilled in part with rocks that were too large to be handled by the back-hoe digger brought to the scene, it was necessary to use paving breakers. These tools both loosened the frozen earth-and-rock mixture and also served to reduce the larger pieces of stone to sizes that could be readily removed.

Repairs were made by cutting out 3 feet of pipe and welding in a new section having three degrees of curvature. In order to do this, the 47-mile stretch of line between the Eagle and Lambertville stations was exhausted to atmospheric pressure by opening valves at those two points. To provide working room for the welders the bottom of the trench had to be belled out on both sides of the pipe. There, again, the paving breakers were brought into play. Customers eastward of the break, including those on Staten Island, suffered no interruption in service because the second 20-inch line could carry enough gas for their needs.

One of the routine maintenance jobs that has to be performed all along the system is the periodic cleaning of the inside surfaces of the pipes by running mechanical scrapers or "pigs" through them. A pig is a wire brush-rubber cup unit, 4 or 6 feet long, with two encircling bands of rubber at each end that are sized so as to fit rather snugly against the pipe. Around its forward end are wire brushes that sweep the walls as the so-called pig is pushed along under the pressure of the flowing gas. A scraper for a 20-inch line weighs about 500 pounds and one for a 24-inch line approximately 700 pounds. Although most of the gas goes through distillate or natural-gasoline plants before entering the system, some of it may contain condensable hydrocarbons. Minute quantities of oil are also picked up by the gas as it passes through the compressors in the booster stations and mixed with it. In time, accumulations are formed, usually at low points in the line.

These deposits, although small, will eventually reduce the carrying capacity of the system if they are not removed. By keeping a close check on the operating efficiency of the compressors at the various stations, it can readily be determined when any section needs cleaning. A pig is then inserted and run through. In order to do this while the line is under pressure, scraper pits are provided at each station.

A pig is put into and withdrawn from the section in somewhat the same manner men and materials are "locked" in and out of a tunnel driven under air pressure. A length of pipe, of the same size as the transmission main, extends from the latter into the scraper pit. On this link and near the junction is a valve that is normally closed. The scraper-pit end of the section is dead-ended by a steel plate that is secured to a flange on the pipe by heavy bolts and nuts. When a pig is to be inserted, the plate is removed, the pig put in, and the plate replaced. Then, by means of a connection near the dead end, gas bled from the transmission line is introduced behind the pig, the valve is opened, and the pig is pushed into the main. When it reaches the point where it is to be removed, the same operations are performed in reverse order. Pushing the accumulation it has gathered during its journey ahead of it, the pig is run into the scraper pit. The large nuts that hold the end plate were formerly run on and off by hand wrenches. Now that work is done much more quickly and with little muscular effort by means of an impact wrench. An accompanying picture shows the operation.

In addition to this cleaning service, pigs are run through the line after a break has been repaired to purge it of air that might form an explosive mixture with the gas. When a break occurs, the nearest valves, both upstream and downstream, are closed to isolate the section concerned. Other valves near the first ones are then opened to "blow down" the section—that is, to relieve the gas pressure. This facilitates making repairs and minimizes attendant hazards. Valves of both types are located on each side of every compressor station, as well as at some intermediate points. After repairs have been made, the upstream blow-down valve is closed, gas is again admitted to the section that was isolated, and a pig is inserted. Meanwhile, the blow-down valve at the downstream end is left open. When the pig reaches that point it is known that all the air has been expelled and that that particular stretch of the line is again filled with gas. Accordingly, the pig is removed, the blow-down valve is closed, the main flow valve is opened, and regular service is resumed.

It is of interest to note that a pig travels around 15 or 20 miles an hour when performing its normal cleaning job with the entire line under pressure. However, with a downstream blow-down valve open following a break and with the gas discharging against atmospheric pressure, a pig may attain a speed of 70 miles an hour or more if 60 or 70 pounds line operating pressure is admitted to the section being purged. As too much speed sets up friction that

SCRAPER-PIT OPERATIONS

Cylindrical scrapers or "pigs" are periodically run through the line to clean it and are put in and taken out in pits into which extends a dead-end spur from the main line. The end plate on the 20-inch segment shown at the left is secured by a ring of closely spaced 2 9/16-inch nuts on 1 5/8-inch bolts. Removal and replacement of these nuts by hand was formerly a laborious, time-consuming job. Now it is done in a few minutes with the aid of a Size 577 impact wrench, as illustrated. Above is pictured the forward end of a "pig" being withdrawn from a pipe section.

burns the rubber bearing rings on the pig, care is taken to control the volume of gas admitted so as to reduce the rate of travel to a safe limit.

Of further interest is the fact that pigs that become stuck can now be detected by pipe-line operators by the use of a uranium prospecting instrument that came into prominence as a result of the atomic-bomb development. By tagging the scraper with a small amount of uranium-bearing compound, it is possible to spot it quickly and definitely by walking along the line with a Geiger-Muller counter. Heretofore, a stuck pig was located by listening for the sound of gas pushing past it, and that sometimes proved to be a tedious and time-consuming task.

An important tool developed recently by the Mueller Company, of Decatur, Ill., for pipe-line work is a power-operated tapping machine that permits tapping a line under pressure with safety in making connections or installing valves. The unit shown in accompanying illustrations makes openings in pipe by removing circular sections from 2 to 12 inches in diameter and is powered by a compressed-air motor that turns its cutting head at about 30 rpm. The tap is made through a previously affixed valve, which can be closed as the head is retracted. The piece cut out, called a coupon, recedes into the head and is withdrawn with it. The tapping machine is held in working position by firmly bolting it to the valve flange, and an impact wrench saves considerable time and effort in running the nuts on and off. Texas Eastern maintenance men say that a tap that formerly required 45 minutes of handwork can be completed with the Mueller machine and an impact wrench in around twelve minutes.

Although the 3R-30 compressor used by Texas Eastern is new to the construction industry, it is well known to railway-maintenance-of-way forces. It was developed to furnish power for various track tools, especially tampers for working stone ballast underneath ties. It is the lightest and most compact unit available for this purpose and, consequently, can be easily moved about and spotted between tracks out of the way of passing trains. This last-mentioned feature led to its designation as the "Spot-Air" in railroad circles. The machine met the conditions for which it was designed so well that it was recently offered to the construction industry for services where ready portability and operating reliability are of first importance. Despite its small size, the unit contains high-grade materials and is constructed with the same care and accuracy as are larger compressors. As a result, it will stand up for a long time under hard service. Its design facilitates maintenance, for cylinder heads, valves, carburetor, and magneto are readily accessible for cleaning or adjustment.

Extreme compactness is obtained by mounting the unit's three gasoline-engine driving cylinders and its three compression cylinders radially around a vertical crankshaft. This arrangement conserves so much space that the complete machine, which delivers 30 cfm. of air at 80 psi. pressure, occupies a circular base only 26 inches in diameter and is only 28 inches high. It weighs approximately 250 pounds, and by slipping a removable horizontal lifting bar in place two men can lift and carry it. These features obviously represent real advantages in pipe-line service, where it is often necessary to move a compressor over rough terrain to reach off-road working sites.

The 3R-30's wheelbarrow mounting includes a pneumatic-tired wheel that enables one man to push the machine over uneven ground without great effort. Ordinarily, however, Texas Eastern dismounts the compressor and transports it in a Dodge Power Wagon, as accompanying pictures show. This vehicle can be driven over unimproved side roads or even through fields and usually gets to or closely approaches its destination. If a considerable distance remains to be covered, the compressor can be quickly remounted and wheeled along the cleared right of way to the scene of operations. Where the distance is short, as it generally is, it can be carried by two men after inserting the bar provided for the purpose.

Each maintenance headquarters has one of these Power Wagons, which has a winch and a gin-pole framework fabricated from pipe mounted on the front of it. The winch is standard equipment on the truck and is driven by power take-off from the engine. For handling heavy loads, a wire cable is run from it and reeved through a pulley on the outer end of the frame. When a job calls for the use of the Mueller tapping machine, the latter is ordinarily transported suspended from the gin poles. Upon reaching the working area it can then be lowered into operating position without further handling. All other necessary tools and a crew of three or more men are carried by the wagon.

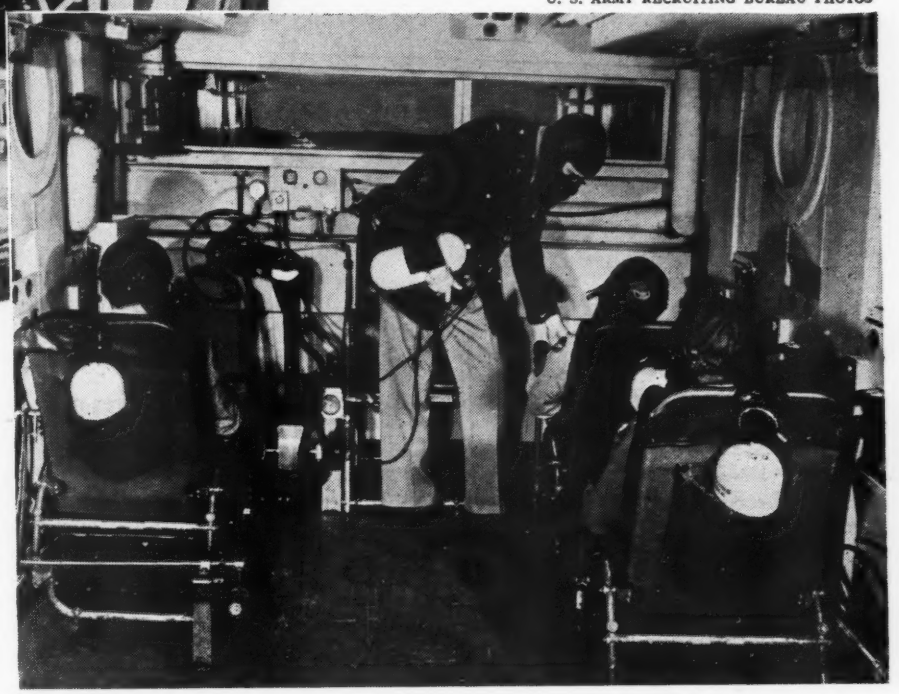
Each crew based elsewhere than at headquarters locations has a pick-up truck to haul tools and men. As previously noted, such a crew will, when occasion demands, borrow a Power Wagon from its headquarters' unit, together with any additional tools or equipment that may be needed. When more air is required than one 3R-30 can furnish, an identical compressor can be obtained from an adjacent section of the line, or one of the two trailer-mounted 105-cfm. machines can be borrowed.

In the past, most maintenance work on natural gas pipe lines has been carried out with either electric- or hand-powered tools. Use of electric tools is limited to areas served by power lines and where no explosion hazard exists. Neither of these restrictions applies to air-powered tools to which, as well as to portable air compressors such as the 3R-30, no location is inaccessible regardless of the distance from a travelable road or the roughness of the ground to be covered. And they have a decided advantage over hand tools in their time- and labor saving potentialities.

RUNNING NUTS ON VALVE FLANGE

Here a Size 577 impact wrench is shown completing the job of running 2 5/16-inch nuts on 1½-inch bolts to hold a large valve on its flange. By using adapters, the wrench will handle nuts for bolts ranging in thread size from 1¼ to 4 inches. Compressed air for operating it is supplied in this case by a "Mobilair" trailer-mounted 105-cfm. compressor.

FLYING UNDER PRESSURE



HIGH-ALTITUDE TRAINING

The flight surgeons who examine prospective Army airmen and later watch their health closely during training are themselves given intensive instruction in every phase of high-altitude flying. By thus gaining intimate knowledge of the attendant physiological problems, they are better able to devise ways and means of combating them. The picture at the left shows aviation medical examiners learning about modern flying equipment during a simulated high-altitude flight in an oxygen chamber at the U. S. Air Force School of Aviation Medicine, Randolph Field, Texas. Below, an air crew is becoming familiar with oxygen apparatus in the Aero Medical Laboratory at Wright-Patterson Field, Ohio.

U. S. ARMY RECRUITING BUREAU PHOTOS

MAN was created to walk on the ground, to breathe rich air at near sea-level altitudes, and to move at rates of speed to which he could easily adapt himself. The airplane, which travels at speeds faster than sound, has taken men miles into rarefied atmospheres. The lack of oxygen at those altitudes, the forces and strains to which the human body is subjected at extremely high speed, the quick changes in temperature, and the mental strain under which pilot and crew live while aloft, have posed new medical problems.

When World War II began, the immediate problem was to find a means by which airplane personnel could be provided with sufficient oxygen when flying at high altitudes. At 10,000 feet, the first symptoms of a condition called anoxia—lack of oxygen—are experienced. Its onset is gradual and insidious, and the aviator feels exhilarated, as if he were capable of performing great deeds. Actually, his mental functions and the exercise of good judgment are already beginning to be impaired. At 18,000 feet, physical activity is greatly lessened, and at 20,000 feet useful consciousness lasts only fifteen minutes without artificially supplied oxygen.

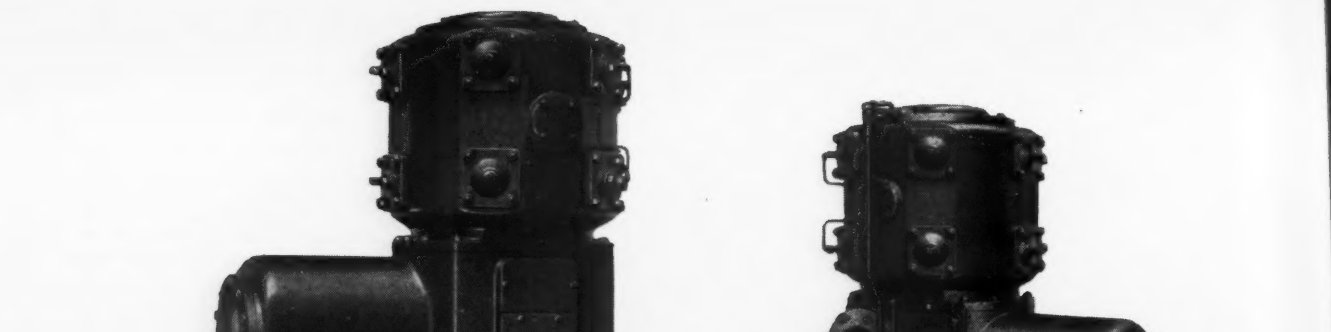
The oxygen mask made it possible for men to take machines up to heights of 40,000 feet with safety and comparative comfort. At altitudes between 35,000 and 40,000 feet, a special mask and regulator that furnishes oxygen under pressure is adequate. But above 40,000 feet, it was determined that even 100 percent oxygen from a mask was insufficient because of the great drop in atmospheric pressure. However, medical research has discovered that oxygen can be satisfactorily inhaled if the atmospheric pressure within the cabin and cockpit is increased and that a flier is much more comfortable in consequence because of the greater equalization of pressure within and outside of his body.

At high elevations, temperatures drop to as low as 55 degrees below zero and crews are confined in small spaces where exercise and movement are either impossible or very limited. The clothing initially worn by airmen who ventured into those areas consisted of Artic-type fur-lined boots, parkas, and helmets and was found to be too bulky. Then an electrically heated flying suit was provided. Comparatively light in weight and comfortable, it retains its warmth for about two hours even if the wiring or electrical system in a plane should be rendered useless.

To combat "blackout" experienced by pilots when changing direction at high speeds, another type of suit was developed. The centrifugal force exerted by such a sudden change sends the blood from the head into the abdomen and legs, causing vision to fail (blackout). If the centrifugal force is not released the aviator collapses, a dangerous thing to happen in an airplane depending upon him for control. The blackout or "G suit" is simply a loose garment—coveralls—containing three bladders, two surrounding the legs and one around the abdomen. When inflated, they constrict the blood vessels, the blood stays in the head, and the dreaded blackout is prevented.

Although still in the developmental stage, experiments are being conducted with human volunteers and equipment by which a pilot can handle his ship while he is prone. That position enables him to be comfortable for up to eight hours of continuous flying. Especially built equipment give him the same control of his plane as when sitting, and the centrifugal force to which the body is subjected when prone is far less than it would otherwise be.

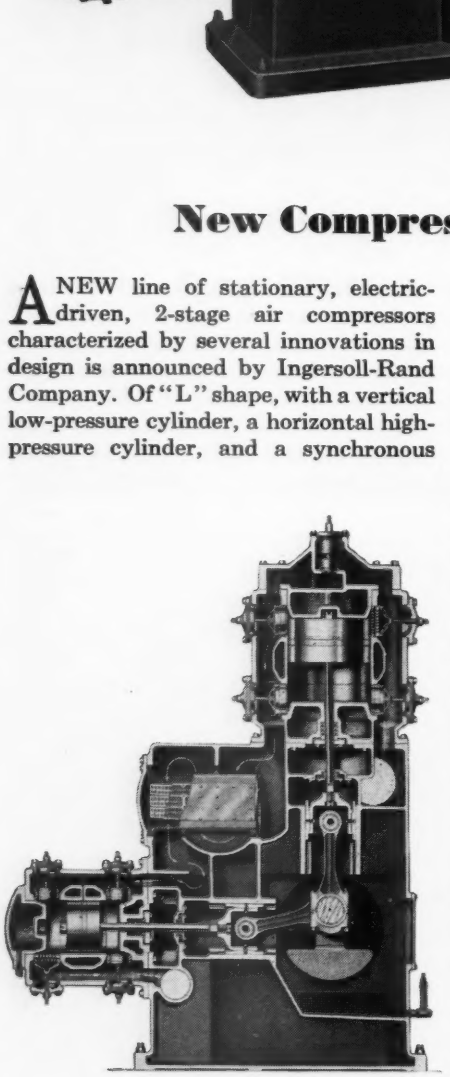
The foregoing material was condensed from an article, "That Men May Fly," in the magazine "Life of the Soldier and the Airman," published by the Recruiting Publicity Bureau, U. S. Army, Governors Island, N. Y.



THE XLE SEEN FROM BOTH SIDES

New Compressor Presents Innovations in Design

A NEW line of stationary, electric-driven, 2-stage air compressors characterized by several innovations in design is announced by Ingersoll-Rand Company. Of "L" shape, with a vertical low-pressure cylinder, a horizontal high-pressure cylinder, and a synchronous driving motor mounted directly on the crankshaft, the new units are notable for their compactness and streamlined appearance. They are available in six sizes from 125 to 350 hp. for continuous, full-load compression to discharge air at pressures of 80-125 psi.



CROSS SECTION

Arrows show path the air travels from the vertical low-pressure cylinder downward through the intercooler at left-center and then into the horizontal high-pressure cylinder for the second stage of compression. This is the first compressor ever developed with a pipeless, through-frame air flow.

Designated as the XLE, the machines are of the completely packaged type that can be shipped fully assembled. The tube-and-fin intercooler of all-copper alloy is only a quarter the size of a conventional tube-nest cooler of equal capacity, and is built inside the compressor frame. This makes possible a pipeless, through-frame air flow that eliminates external piping and protrusions and permits true streamlining. Interstage pipe connections, with their attendant strain on cylinders, are absent.

In addition to producing a pleasing appearance, the design features make for sturdy construction and a compressor that is extra strong and rigid, easy to transport, set up, and keep clean. Being compact it also conserves floor space and lessens foundation requirements to a noteworthy degree. The 125-hp. size, which has a piston displacement of 800 cfm. and operates at 600 rpm., is 7 feet 4 inches long, 5 feet 6¼ inches wide (including motor), and 7 feet 3 inches high. It can be placed on a 1½-cubic-yard base. The 350-hp. machine, with a piston displacement of 2280 cfm. and a running speed of 450 rpm., is 10 feet 3 inches long, 7 feet 2 inches wide, and 11 feet 2 inches high, and needs not more than 6½ cubic yards for its foundation.

All bearings in the XLE are full-floating and rotate freely on both the bearing journal and within the rod or bearing housing. Main and crankpin bearings are of aluminum alloy. Combined with pressure lubrication in a sealed, dust-tight crankcase that does not have to be opened for bearing adjustment, the construction is said to result in cool-running bearings, long trouble-free service, and low maintenance cost. The compressor valves are a new design of the established channel type.

The XLE is normally shipped as a complete unit ready to run as soon as it is placed on its foundation and air, cooling-water, and electrical connections are made. Controls are simple and grouped for the convenience of the operator. Operating economy is effected at partial and full loads by means of a 5-step cylinder clearance control that has been used on I-R electric-driven compressors for 40 years.

Designed to answer the needs of heavy-duty service of all kinds, the new units are well adapted for use in factories, railroad shops, powerhouses, and mines, as well as on large construction jobs. They are especially suitable where floor or ground conditions require a well-balanced machine.

Additional information and descriptive literature may be obtained from Ingersoll-Rand Company, 11 Broadway, New York 4, or any of its branch offices.

This and That

Aid for French Africa

Development of French West Africa is being furthered with $31,000,000 in American goods and machinery allocated under the Marshall Plan. Highways and railroads are to be improved with the aid of $1,500,000 worth of our equipment. In the "dead" delta of the Niger River 200,000 acres will be planted to rice and irrigated with water diverted into canals by the Sansanding Dam on the Niger at Markala. Mechanical peanut pickers have been sent to the Senegal region where it is proposed to raise goobers on 80,000 acres to alleviate a shortage of cooking oils and oilcake cattle feed in France. Iron deposits are being opened up in the Conakry area and $160,000 worth of compressed-air equipment is being provided for the purpose of developing phosphate deposits.

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Puzzling Aspects of Sound

Research in the field of noise reduction is bringing to light some peculiarities of sound that are puzzling investigators. For instance, the noise of crickets makes sufficient impression on the human ear to be disturbing but is not loud enough to register on most sound-measuring instruments. By the same token, there is no instrument that will distinguish between the playing of the same note on a Stradivarius and on a hillbilly's fiddle, although the human ear does so. The explanation is believed to lie in the fact that in both cases there is a tiny wavering of the sounds that gives them characteristics which the ear can detect but which instruments cannot measure. In consequence of these findings, according to Dr. R.O. Fehr, General Electric Company noise researcher, engineers are beginning to study sounds in terms of their changing quality as well as in terms of loudness and frequency. "This approach," he states, "promises new understanding of sound problems, and new advances in sound engineering should result."

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Lake Shore Profits Pass $100,000,000

Lake Shore Mines, Limited, one of the principal gold-mining enterprises in Canada, passed a significant milestone in March. With the mailing midmonth of dividend checks, total payments to shareholders reached the hundred-million-dollar mark. During more than 31 years of continuous activity, the mine has produced in excess of $220,000,000 worth of gold. This was recovered by breaking, hoisting, and milling nearly 13,500,000 tons of ore. Operations to date have involved purchases of supplies and equipment costing more than $41,000,000. These included expenditures of $1,042,000 for rock drills and parts and slightly more than $3,000,000 for explosives.

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Pneumatic Drill for Surgery

Although the first pneumatic tool of record was a small one devised by a British dentist for compacting metallic fillings in teeth, it failed to establish a trend. Instead, air-operated tools of larger sizes were put to immediate use principally in the metal-working industries. Such small tools as were developed were chiefly employed by the stone carver or cutter. In the main, however, the tools tended to grow bigger all the while, and some, such as impact wrenches, now weigh up to 70 pounds. With the advent of World War II, the needs of the airplane industry prompted the manufacture of small tools that could readily be operated by women. These have since been applied to the making of a wide range of products but are, for the most part, still working on or with metals.

Now, with the introduction of a small drill for the use of bone surgeons, we find pneumatic tools coming back to the field in which they originated. It has taken some 70 years to complete the circle. The new drill was recently demonstrated to members of the American Academy of Neurological Surgery. It is designed especially to assist in spinal-column operations. Its particular value lies in the fact that it permits performing extremely delicate bone surgery at a faster rate and greater safety than with instruments wielded by hand. It promises to be a boon in mastoid operations and in the bone work of orthopedic surgery.

The tool, which is capable of operating drills up to ¼-inch diameter, is powered by either compressed air or compressed nitrogen. The latter is used oftenest because it is readily available in steel bottles. A standard cylinder of nitrogen will run a tool for 22 minutes, which is reported to be long enough to do all the drilling necessary for five average operations.

To insure sterile propulsive gas, Prof. E.G.D. Murray of McGill University, Canada, developed a special filter that makes use of Pyrex-glass wool to capture dirt and germs. It was tested by blowing germ-laden peat dust through it at 100 psi. pressure for 30 minutes. Only that part of the wool with which the mixture first came in contact was found to be discolored and contaminated.

The tool will operate saws as well as drills, which may be run either in line with the tool or, by means of attachments, at right angles to it. A pistol-grip handle, ordinarily attached by a set screw, may be quickly removed when desired. Electric-driven tools have been used in surgery for some years, but they are objectionable in cases where combustible anaesthetics are employed. The new drill presents no such hazard.

With the aid of the pneumatic tool, sections of the vertebral bone structure at the back of a patient's neck were recently removed and the structure was then wired together. The operation required three hours, but would have taken almost twice as long without the surgical accessory.

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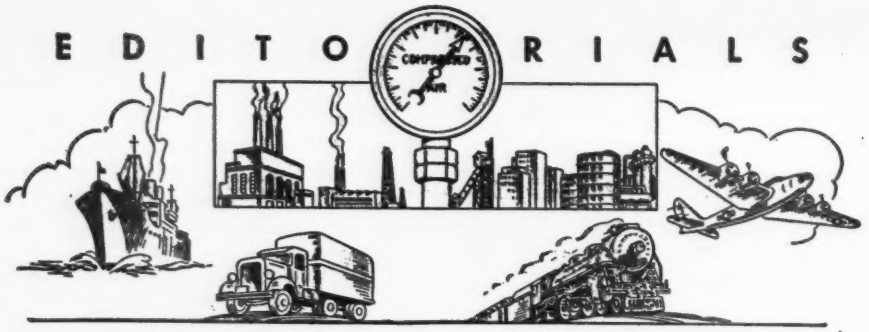
Dry Air Thwarts Corrosion

Damage wrought by corrosion is heavy on tankships and increases when operations take the vessels into tropical areas where atmospheric humidity is high. Removal of rust alone costs from $5000 to $10,000 per tanker annually, and one American company estimates that it spends on an average $85,000 a year throughout the life of a ship to repair and replace bulkheads, piping, and strength members weakened by corrosion. Corrosion of tank interiors is aggravated by acids, sulphur, and other metal-attacking substances contained in all petroleums, especially if moist salt-laden air is present. Gasoline is even more corrosive than crude oil.

It is claimed that corrosion can be reduced as much as 80 percent by lowering the humidity inside tanks. To accomplish this, a machine called the Cargocaire has been developed to supply dry air to storage areas. The space above the liquid carried in tanks is maintained under slight pressure with desiccated air while in transit. This air drives out moist air and prevents more from entering. The system functions automatically by admitting additional air whenever the pressure drops to a predetermined point.

The tanker's piping system is also kept filled with dry air to prevent corrosion. After tanks have been emptied, they are charged with moisture-free air to protect them. This also forces out residue gases that might cause explosions. The Cargocaire can be operated in conjunction with flue-gas systems that are used to maintain tanks in a nonexplosive condition at all times.



OUR PERIODICAL PURGE

PURSUING a long-established practice, COMPRESSED AIR MAGAZINE has recently completed checking its circulation list. As usual, this was done by mailing a questionnaire to each recipient of the magazine and, where necessary, a duplicate form as a follow-up. The primary purpose of the check is to verify names, addresses, and titles, and to remove from the list names of deceased persons and those who, because of retirement, change of position, etc., are no longer interested in reading the publication. Secondly, the object is to find out how readers like the magazine and to give them an opportunity to make suggestions for its improvement. We also ask how many individuals other than the recipient of record read each copy.

Our circulation list of more than 30,000 names is canvassed in this manner at intervals of approximately 24 months. Over the years an average of 85 percent of those queried have responded (85.4 percent in the case of the recent check). This is well above the usual response to questionnaires of this sort, according to authorities on such matters. The 15 percent who do not return the forms are checked by field representatives.

The check normally results in removing around fourteen percent of the names from the list. The saving effected by reducing publication and mailing charges just about equals the cost of conducting the survey. However, it assures us that we are sending the magazine to only those who want it and, consequently, are spending our production dollars effectively. In addition, it assures advertisers that they are getting full value for their expenditures for space. They know we have what the trade calls a "clean list." It is, in fact, so free from "deadwood" that experienced and investigation-minded advertising men rate our pages among the best in the technical publishing field in which to put their messages. Approximately 200 new names are normally added to the list monthly. Consequently, by the time the next check begins, our circulation will again be around 30,000.

We have used the same questionnaire for many years. It is as fair and unbiased as we can make it. Some periodicals that canvass their readers frame their queries so that they will produce the desired answers. The only place where readers can express opinions on the job we do is headed: "Suggestions for editors and advertisers." Respondents are free to criticize or praise, as they please. Obviously, a questionnaire that does not attempt to influence the replies in any way is the only kind that will obtain impartial and honest information. If a magazine seeks and gets facts by devious methods, it is only kidding itself. Furthermore, in presenting its so-called findings to prospective advertisers it is guilty of misleading them, to say the least. Fortunately, advertising managers and advertising agencies aren't easily beguiled. Biased surveys and questionnaires usually prove to be boomerangs for the publications that instigate them.

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ROBOT COMPRESSOR STATIONS

AUTOMATIC or unattended compressor stations in oil and gas fields are becoming fairly common, and two recent articles in these pages have described specific installations. Although they are still so new that the operating data regarding them is not abundant, the evidence seems to indicate that they are highly successful. This is the conclusion reached by T. S. Bacon of the Lone Star Gas Company, Dallas, Tex., in a paper recounting his firm's experiences with them.

A Lone Star automatic station at Cayuga has operated 96.3 percent of the elapsed time since it went into service four years ago. Assuming that it is reasonable to allow 0.5 percent down time for maintenance of any internal-combustion engine, this performance is within 2.2 percent of the best that might be expected. The cost of this down time was actually considerably less than the sum that would have had to be paid out in wages if the plant had continual attendance.

Compressor stations in oil fields normally run 24 hours a day. At prevailing labor rates, the outlay for attendance of a station handling a million cubic feet of gas daily is about $12,000 a year. This amounts to a charge of three cents per 1000 cubic feet. Automatic operation will not eliminate all wages because some maintenance work must be done during the life of the station. However, it will generally result in worth-while savings, especially in the case of small stations.

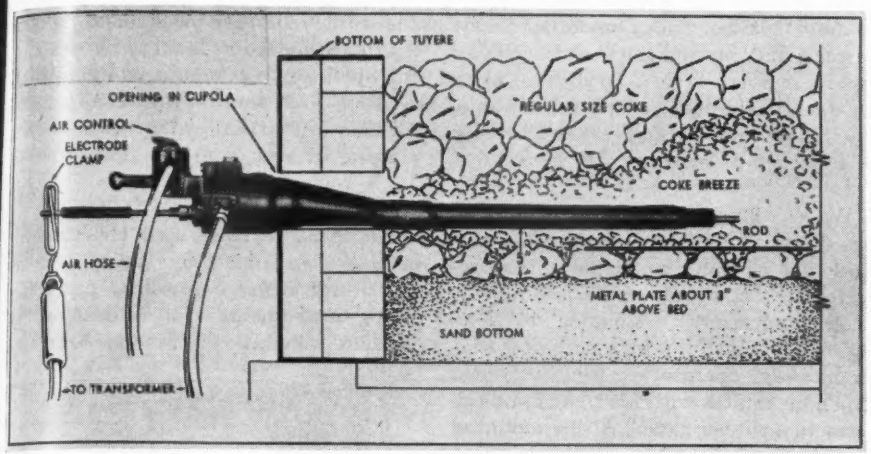
In addition to reducing payrolls, automatic controls create more desirable operating conditions than are possible with human attendance. This is true, for instance, with respect to obtaining optimum temperatures of cylinder-jacket cooling water and of crankcase lubricating oil. Automatic devices will hold them closer to ideal conditions than will manual control. Moreover, automatic controls can do a better job than human supervision in the matter of making compressors respond quickly to load fluctuations.

The greatest disadvantage of automatic control so far revealed is that, without human attendance, there is a time lag in getting at the job of correcting conditions that cause a station to cease functioning. Maintenance work done on a regular and well-planned schedule will, however, substantially reduce down time by correcting causes of stoppages before they become acute. For example, Lone Star Gas has found that spark plugs in the power ends of gas engine-driven compressors should be replaced after they have operated 80 percent of their life expectancy. Following this policy, it makes a practice of renewing them every 90 to 125 days and has consequently experienced only one engine shutdown through spark-plug failure.

Pursuing the same line of preventive maintenance, the company checks each compressor unit every twelve months to determine the condition of all bearings, cylinders, and the cooling system. In this manner incipient troubles, that might arise from such things as corrosion, scale, and cylinder and ring wear, are for the most part nipped in the bud. Another conclusion reached by Lone Star is that pneumatic controls are more reliable than electrical controls and are easier to apply.

Mr. Bacon summed up his discussion with the prediction that automatic compressor stations are here to stay. "Present reliability of the mechanical equipment and of control equipment required in such stations is excellent and is improving from year to year," he stated. "Costs for maintaining constant human attention have increased very substantially during the past several years, and may or may not increase in the future. In any event, the present margin of savings in operating costs appears to justify the use of unattended stations in sizes up to at least 2000 hp., where infrequent shutdowns of the station are not too undesirable."

Coke Bed Fired Quickly with Electropneumatic Lighter



IN POSITION FOR USE

The Whiting-Mason Coke Igniter is introduced through the cupola breast or a special opening in the side or back and about 5 inches above the sand bottom. Before the electrode is inserted into the barrel, short blasts of compressed air are blown through the latter to make sure it is free of coke. Igniter is left in place for about 10 to 15 minutes. Then, if coke at right angles to the barrel is not red hot, the unit is withdrawn 8 to 10 inches. When the bed is in that condition throughout, the igniter is removed and regular charges of coke are started.

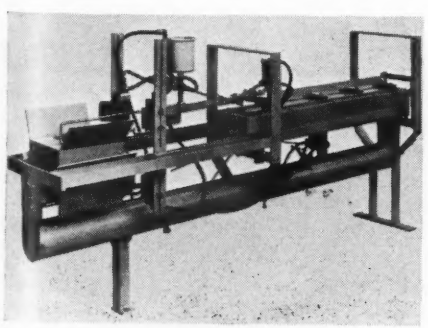
CLEAN, quick, and thorough cupola ignition and hot iron at the first tap are among the advantages claimed for a coke igniter built by Whiting Corporation for foundry use. The assembly is 45 inches long and consists essentially of an igniter body, a 1¾-inch barrel, an electrode holder, a vibrator tube, and a booster pipe. In operation the barrel, which is inserted into the coke breeze, serves as a ground to strike an arc within the coke bed. This is done by passing an electrode through the insulated tube or holder in the barrel and, at the same time, introducing sufficient compressed air to stimulate combustion. Current is provided by a transformer and compressed air is maintained at a pressure between 80-100 psi.

About twenty seconds after ignition, the vibrator tube containing the electrode holder is withdrawn and the booster pipe is inserted. Air is admitted to the latter through a separate hose connection; and this blast, together with the initial one, is continued as long as the igniter is in the cupola. It is claimed that a well-fused, deep coke bed is obtained within from 20 to 30 minutes without the disadvantages, primarily smoke, incident to the use of gas, oil, or wood and at a lower cost than by any other method. Two and even three units can be used with large-diameter cupolas that necessitate quick firing.

Air-Operated Machine Glues and Seals Cartons

WITH one stroke of a pneumatic cylinder, the Casealer, a recent development of Schroeder Machines Corporation, glues, folds, and seals packing cartons of a variety of sizes. There are two types: No. 100, in which the cartons are automatically stacked, positioned, and opened ready for packing by hand; and No. 300 into which the operator puts the cases, one after another, with the lower inside flaps tucked in and the bottom side flaps hanging down vertically, as shown in the accompanying illustration. This machine is 9 feet long and 20 inches wide and consists of a case-controlling magazine, a 1-gallon glue container, tubular applicators of stainless steel that are normally closed, and a compression unit.

When the carton has been filled, the top inside flaps are closed and held down by a folder. A trip lever then starts the machine, actuating a double-acting pneumatic cylinder that moves the package ahead and controls both the glue applicators and the compression unit. The former can be opened any desired degree by turning an air valve to regulate the pressure, thus varying the amount of adhesive applied on rough or smooth surfaces and with the top and bottom flaps in the vertical position. Next, the folding rods close the flaps; the air cylinder lifts the upper half of the compression unit and lowers it again to seal the carton after it has come to rest beneath it. Sealing normally takes one minute, and as the case moves forward, the one at the discharge end of the line is pushed onto a conveyor for delivery to storage or the shipping department.



MANUALLY LOADED TYPE

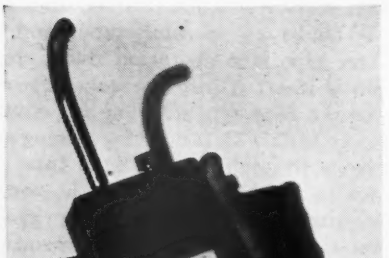
This machine handles cartons from 7 to 16 inches wide, 3½ to 16 inches high, and 6 to 20 inches long, and has a capacity of approximately 300 an hour. It is operated with air at a pressure of 40 psi. and consumes 0.3 cubic feet per case. One double-acting air cylinder performs all the work normally done by chains, gears, cams, motors, and similar complicated mechanisms.

Special Jackhamer Mounting for Road-Widening Job

SOME of our state highway departments require that reinforcing be used to tie a new road slab into the existing one on all concrete-highway widening jobs. This means that the side face of the original slab must be drilled at 2-foot intervals with 1 1/16-inch holes 6 inches deep for the installation of a shield to hold the reinforcing bar. For every mile of road it is therefore necessary to put in 2640 holes. Doing this work with hand-held drills is awkward and slow and results in only 40 to 50 holes per machine per day.

One contractor in New York State has stepped up drilling progress tenfold by using the special drill mounting shown in the accompanying picture. It consists of a 5-inch steel channel attached to the side of a trailer carrying an Ingersoll-Rand 105-cfm. portable air compressor. The apparatus is arranged to hold a J-10 or J-30 Jackhamer in horizontal position and permits raising and lowering the tool so that adjustments for variations in slab thickness can be made. It has increased the daily drilling rate per machine to 400-500 holes.

Industrial Notes



What is described as the first electrical anemometer unaffected by temperature changes has been announced by the Hastings Instrument Company, Inc. Featuring a built-in temperature-compensating probe, the Model G Air-Meter is said to give instantaneous, direct, and accurate readings of air velocities from 5 to 6000 feet per minute, with an expanded scale in the low-velocity range. It is especially suitable for use in connection with process control, air conditioning, and research installations where quick readings are of importance. Separate probes can be obtained for ordinary Hastings anemometers, as well as accessories including a carrying case with a battery-operated power pack for service where 110-volt alternating-current is not available.

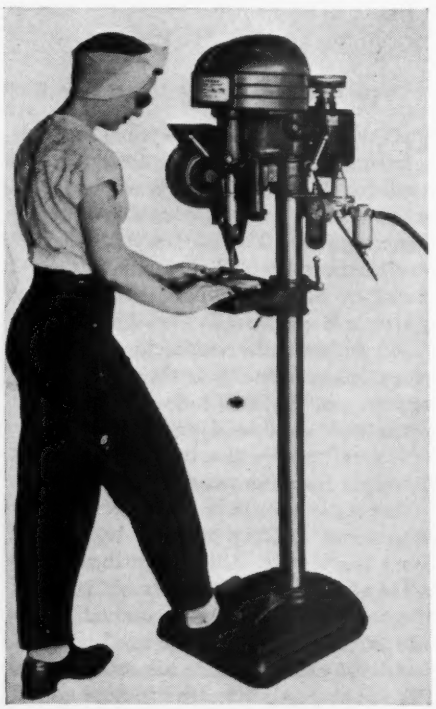
Impregnating nylon, cotton, rayon, and wool with aluminum flakes by a new process is said to make those materials warmer than they normally are. A rayon-satin lining, for example, will provide 12 percent more warmth when treated than when unprocessed, while a nylon seersucker cover will be superior in this respect to a 3½-pound wool blanket.

Canada's Roberval & Saguenay Railway has lately put in service a boxcar with an all-aluminum body which is believed to be the lightest of its size and type in existence. It weighs only 43,400 pounds, or about 6 tons less than the standard United States car of less capacity. Its first load of 2243 bushels of grain weighing 134,580 pounds was a record breaker.

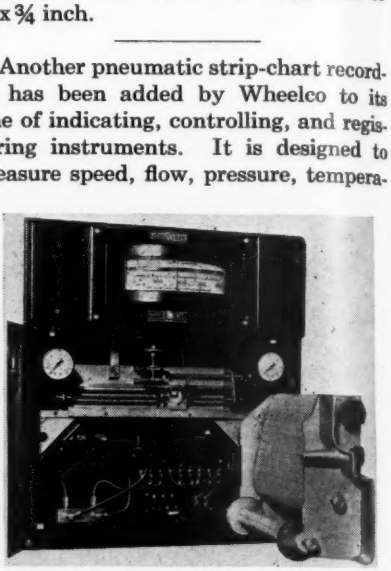
For carrying coolants to welding heads, gas to soldering torches, and compressed air to pneumatic tools, General Motors Products of Canada, Ltd., has developed a vinyl-plastic hose of its own that is said to be superior in a number of respects to the conventional type. According to the company, it lasts four or five times longer, costs half as much, is more flexible, has a smoother inside surface, and permits the use of a smaller size for a given service. In the case of an air-operated impact wrench, for example, a 9/32-inch plastic hose takes the place of a ½-inch-diameter rubber hose.

W. W. Sly Manufacturing Company has designed a bench-type blasting machine for cleaning small parts that receives its air supply from a 5-hp., 2-stage compressor. Loading is done through a hinged top with a window that enables the operator to see the work, which he rotates with his right hand encased in a rubber glove. A side-mounted light facilitates vision. The unit has a ventilating fan that exhausts the dust into a filter bag.

For industries engaged in mass production there is now available a power screw driver recently announced by Shakeproof Inc., a division of Illinois Tool Works. It was designed in answer to the demand for a high-speed foolproof machine for use with the company's thread-cutting screws and "sems"—preassembled fastening units. Installation involves only plugging into a 110-volt outlet and connection with an air-supply line. Operator puts the screws into a hopper, spots parts to be tied together beneath the spindle, and drives the screws by depressing an air pedal. The hopper feed positions each one properly for its travel down a track to the bit, where it is held firmly until one or two threads are engaged. An automatic clutch disengages as soon as the desired torque is reached, thus preventing overtightening and breaking or scarring of the work. Another mechanism protects the machine from damage by enabling the operator to release a jam caused by a wrong-sized screw. Unit is adjustable for screws of virtually all types and styles ranging in size from No. 1x⅛ inch to ¼x¾ inch.



Another pneumatic strip-chart recorder has been added by Wheelco to its line of indicating, controlling, and registering instruments. It is designed to measure speed, flow, pressure, temperature, static grain loads, voltage (both alternating- and direct-current), amperes, etc., and is said to perform its control function with ease and accuracy by the smooth floating power of compressed air operating valves, dampers, levers, pistons, etc., through diaphragm motors. The instrument, known as the Pneumatic Capacilog, is self-contained and has only two external air connections.



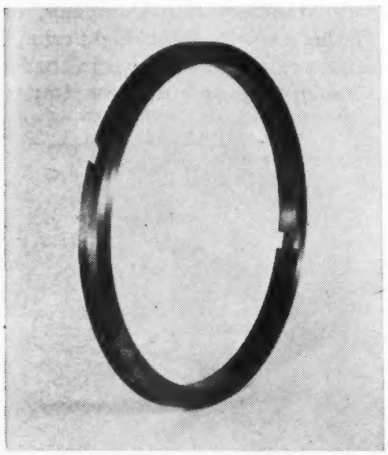
A metallic rod wiper for pneumatic and hydraulic cylinders has been introduced under the name of Seal-Guard by Hydraulic Accessories Company. It is made of two flexible bronze rings mounted in synthetic rubber and has knife-edge conical surfaces that protect the rod and packing by removing abrasive substances. The wiper is self-adjusting.

It is contradictory to use a welder to pull metal apart, but that is being done at the plant of the Ohmite Manufacturing Company in making harrow teeth. Formerly, a skilled hammer operator forged one at a time from steel bar stock. Today, a bar about 12 inches long is gripped between the terminals of a welder, current is applied, and the steel is allowed to become red hot. At that stage an air cylinder exerts a pull on the jaws, severing the bar and forming two harrow teeth ready for assembly.

As a supplement to conductive floors in munition and other plants where there is danger of explosions, Walter G. Legge Company has designed an antistatic device to be worn by workers. It consists of a retractable contact pin that is

clipped under the shoe and connected by a chain and spring to an adjustable garter. It is said to insure positive electric contact between the floor and the body and to drain off static charges despite the insulating effect of shoes and socks and deposits of wax or grease on the soles.

A cylinder and shaft seal of new design has been developed by The Auto-Diesel Piston Ring Company. Of all-alloy 3-piece construction, it is said to prevent or retard tarnish, rust, or other corrosion by contact with different hydraulic solutions and to eliminate "blow-by"—leakage of air, gas, or liquid past a piston



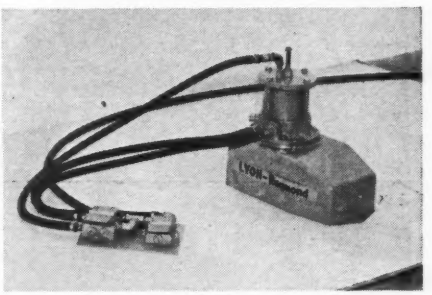
ring or similar circular part and through the step, insert, or split in the ring by which it is expanded for installation in the piston groove or in the retaining groove around a shaft. The seal has one inner ring with two extremely close-fitting outer rings, the steps in the former being staggered so that blow-by, even after much wear, is avoided in most cases.

Oil-well drillers are experimenting in a California field with a sonic pump to bring crude oil to the surface. According to the American Petroleum Institute, the sound waves cause the drill tube to contract and expand sufficiently to lift the fluid from the depths.

"Automation" is a word recently coined by industry to define the process of converting a hand to an automatic operation for the dual purpose of reducing cost and physical effort on the part of the worker. It is used a number of times in the preliminary program of the convention of the American Society of Tool Engineers to be held on April 10 in Philadelphia, Pa.

Kinsalloy is the name of a new alloy that is said to resist the searing heat of a jet engine. It was produced by Harold V. Kinsey, a metallurgist of the Canadian Bureau of Mines, and is 10 percent lighter than similar metals. Tests have proved that it can withstand a temperature of 2100°F. for as long as 1000 hours while subjected to a heavy load.

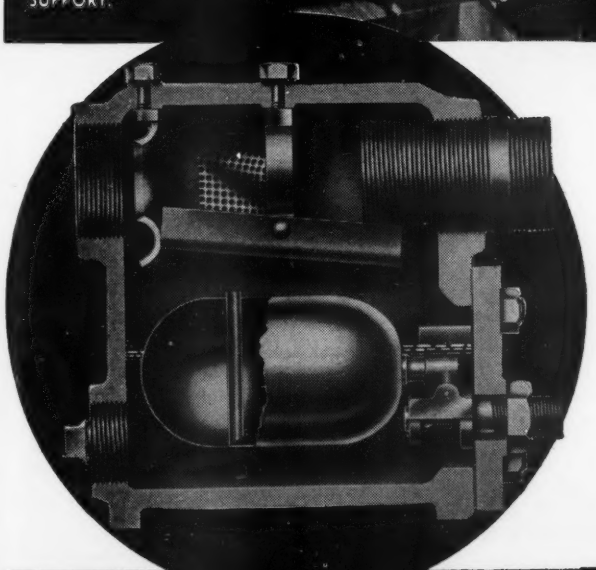
For use with its own materials-handling equipment but also generally available, Lyon-Raymond Corporation has designed an air-operated hydraulic pump of the single-acting type. It develops a working pressure of 1000 psi. with air at



90 psi., and pumps oil at the rate of 1 to 1½ gpm. A foot-controlled reciprocating valve alternately diverts the air from one to the other side of a pneumatic piston, which is direct connected to a small hydraulic cylinder. The pressurized oil in the latter is returned to the reservoir by gravity through the medium of a release valve actuated by a 3-position, 4-way foot valve that also controls the pumping action. Units with higher working pressures and reservoirs of several styles and

DRI AIR MAY BE INSTALLED BY SUSPENDING IT FROM THE PIPING WITHOUT ANY OTHER SUPPORT.

INCREASED PNEUMATIC EFFICIENCY WITH THIS AUTOMATIC SEPARATOR



PROTECT EQUIPMENT WITH

DRIAIR

SEPARATES • COLLECTS • DELIVERS

• DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

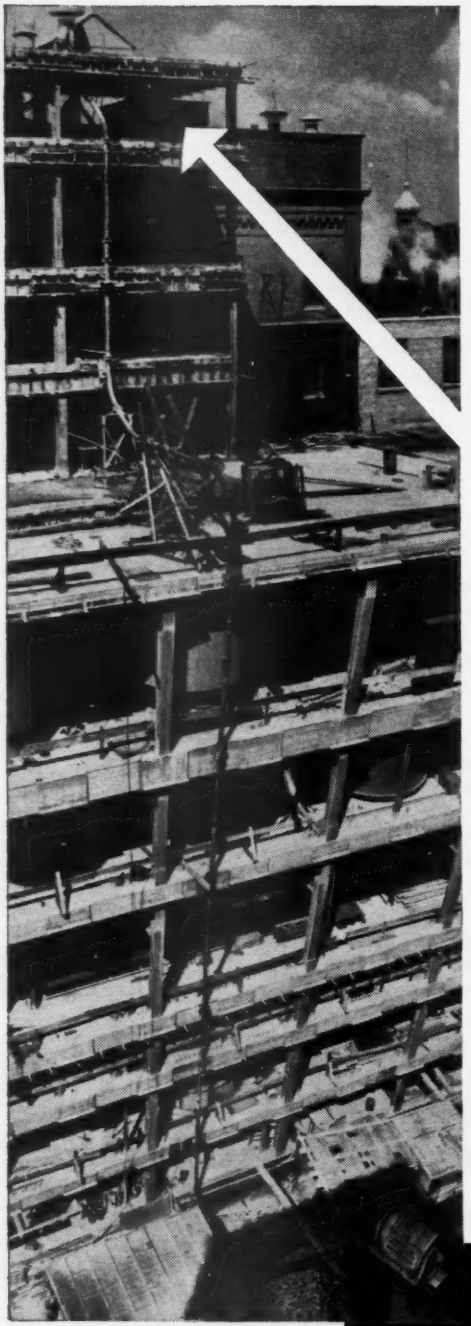
A TYPICAL INSTALLATION SHOWING DRI AIR STANDING ON A CONCRETE FLOOR NEXT TO THE WALL.

WRITE FOR BULLETIN DA WHICH FULLY DESCRIBES THE CONSTRUCTION AND OPERATION OF THE DRIAIR.

NEW JERSEY METER CO.

"SPECIALISTS IN COMPRESSED AIR DEVICES"

PLAINFIELD, NEW JERSEY



9 STORIES UP!

...A NEW RECORD FOR PUMPING CONCRETE

● *Powered by its Waukesha Engine,* a Rex 160 Pumpcrete recently broke all records in Milwaukee for concrete elevation and placement for this size concrete pump.

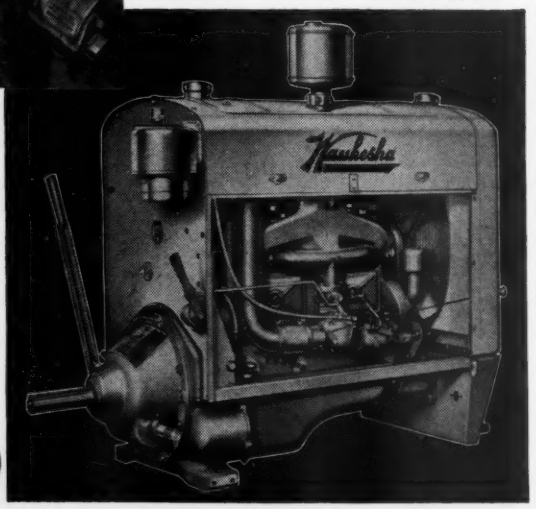
The concrete was lifted to 160 ft., nine stories from the ground to a roof pouring job on a brew house addition of Schlitz Brewing Co. Total pour, 5000 yds. with Waukesha power pushing it through the 6-in. pipe at an average of 18 cu. yds. per hour.

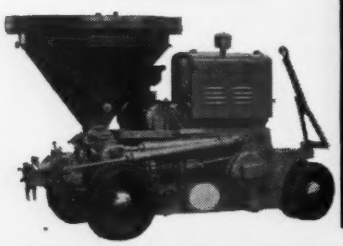
Contractors Edward Steigerwald & Sons, Inc., own and operate the Pumpcrete which was purchased from Hunter Tractor & Machinery Co., Milwaukee.

On every general construction job—Waukesha Industrial Power Units, 5 hp. to 475 hp., gasoline, gas, and Diesel.

WAUKESHA MOTOR COMPANY
WAUKESHA, WISCONSIN
New York • Tulsa • Los Angeles

WAUKESHA Model XAHU—Gasoline Power Unit
powers the 160 Pumpcrete. 4-cyl., 3⅝-in. x 4½-in., 186 cu. in. displacement; 43 hp. max. at 2000 rpm.
Get Bulletin 1408.



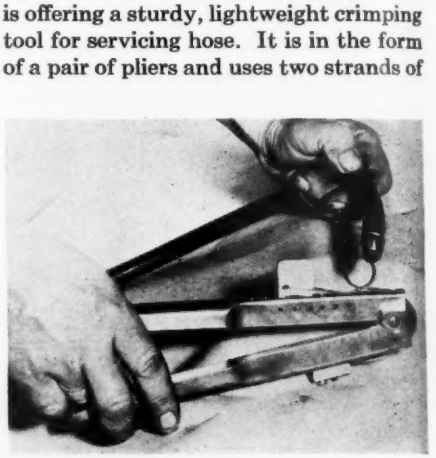


WAUKESHA POWER

sizes are obtainable and are intended for use with hydraulic elevating tables, strip and sheet feeders, and with positioners.

Exposed steelwork that forms part of industrial installations such as are found in oil refineries and chemical plants is sometimes irreparably warped in a fire. We are informed that a layer of a special cement 1¾ inches thick will retard the harmful effects of intense heat for three hours. The protective material, a gray powder, is made by Eagle Picher Company. Mixed with water it forms a stiff paste and is troweled onto ribbed metal lath wrapped around the steel members.

For the convenience of plant maintenance men, A. Schrader's Son Division of Scovill Manufacturing Company, Inc., is offering a sturdy, lightweight crimping tool for servicing hose. It is in the form of a pair of pliers and uses two strands of



looped music wire as the crimping medium. They are attached to the handles in such a way that closing the latter contracts the loops into which the hose has been inserted. Loops can be made for repairing or installing hose from ½ inch to 1½ inches, outside diameter.

Plants that use many files may be interested in a report by Westinghouse Electric Corporation based on tests to determine whether or not it pays to resharpen them. It was discovered that proper care and maintenance, involving either sandblasting or return to the maker for recutting, does effect worthwhile savings. A 6-inch file that cost 25 cents when new was reconditioned by the manufacturer for thirteen cents and restored to service by the sandblast method for 0.052 cent, including sorting, oiling, and wrapping. In the case of a file 16 inches long the figures were as follows: new $1.05; recut, 0.53 cent; and sandblasted, 0.129 cent. A file that is only partly worn and otherwise fit for use can be restored two or three times by sandblasting. Its service life between resharpenings, as compared with that of a new file, averages 85 percent. Files that are worn smooth, and sometimes those that have been sandblasted more than once, have to be sent away for recutting and will be as good as new.

New Books and Industrial Literature.

Hydraulic Institute, 90 West Street, New York 6 N. Y., has published Volume II of *Engineering Papers of Hydraulic Institute.* It contains the following technical papers which won awards in various engineering contests sponsored by the Institute to stimulate interest in the many phases of the pump industry: *Cavitation in Centrifugal Pumps*, by A. J. Stepanoff; *The Centrifugal Pump in the Process Industries*, by A. T. Nielsen; *The Operation of Centrifugal Boiler Feed Pumps*, by Hans Gartmann; and *Submergence for Centrifugal Condensate Pumps*, by Hollis T. Waldo Price of book, $2.00.

The fifth edition of the Bureau of Reclamation's *Concrete Manual* is now obtainable. Prepared by engineers of the Bureau's branch of Design and Construction, the publication has 489 pages and 167 illustrations. It is of handy pocket size. New sections include one on the subject of air entrainment and another on the use and occurrence of pozzolana and its effect on concrete. Copies can be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D. C. Price $1.75.

Bulletin No. DB-2 of Mine Safety Appliances Company, Pittsburgh 8, Pa., describes its improved type of carbon-monoxide detector and recorder. Capable of continuously measuring very low concentrations of carbon monoxide in air, the instrument also operates warning signals, ventilation controls, or proportioning valves.

A 32-page catalogue describing clips, clamps, and brackets made by Thomas Associates, 4607 Alger Street, Los Angeles 39, Calif., is available upon request. It covers more than 12,000 sizes and combinations of standard bare-metal and cushioned line-support clamps and blocks, gives their special features, and suggests applications.

Marine and Industrial Products Company, 3731 Filbert Street, Philadelphia 4, Pa., will send to heating and power-piping engineers a bulletin that will help them select the correct size of safety valve for a given pressure-reducing regulator. Booklet contains test data and charts, together with capacity tables and other information on the firm's line of safety valves. Request should be written on company letterhead.

Engineers and others laying out air circuits may find helpful information in a 16-page catalogue on the full line of Gerotor double-acting, nonrotating air cylinders made by Rivett Lathe & Grinder, Inc., Brighton 35, Boston, Mass. The publication contains drawings and tables of dimensions for each model and size, descriptions of cylinder mountings, and recommendations as to the type of valve best suited for a particular application.

Rubber-lined pipe for corrosive, abrasive, or contaminating liquids, as well as those that tend to build up flow-restricting deposits, is described in Bulletin No. 6907 obtainable from the Rubber Division of Raybestos-Manhattan, Inc., Passaic, N. J. It is especially recommended for water-conditioning systems, sewage disposal, mine drainage, and for use in chemical, textile, paper, metal-refining, glass, and food-preparation plants.

A compound for use in cold drawing hot- or cold-rolled steel bars or rods is the subject

PERFORMANCE That Rates an "Oscar" on Construction Jobs

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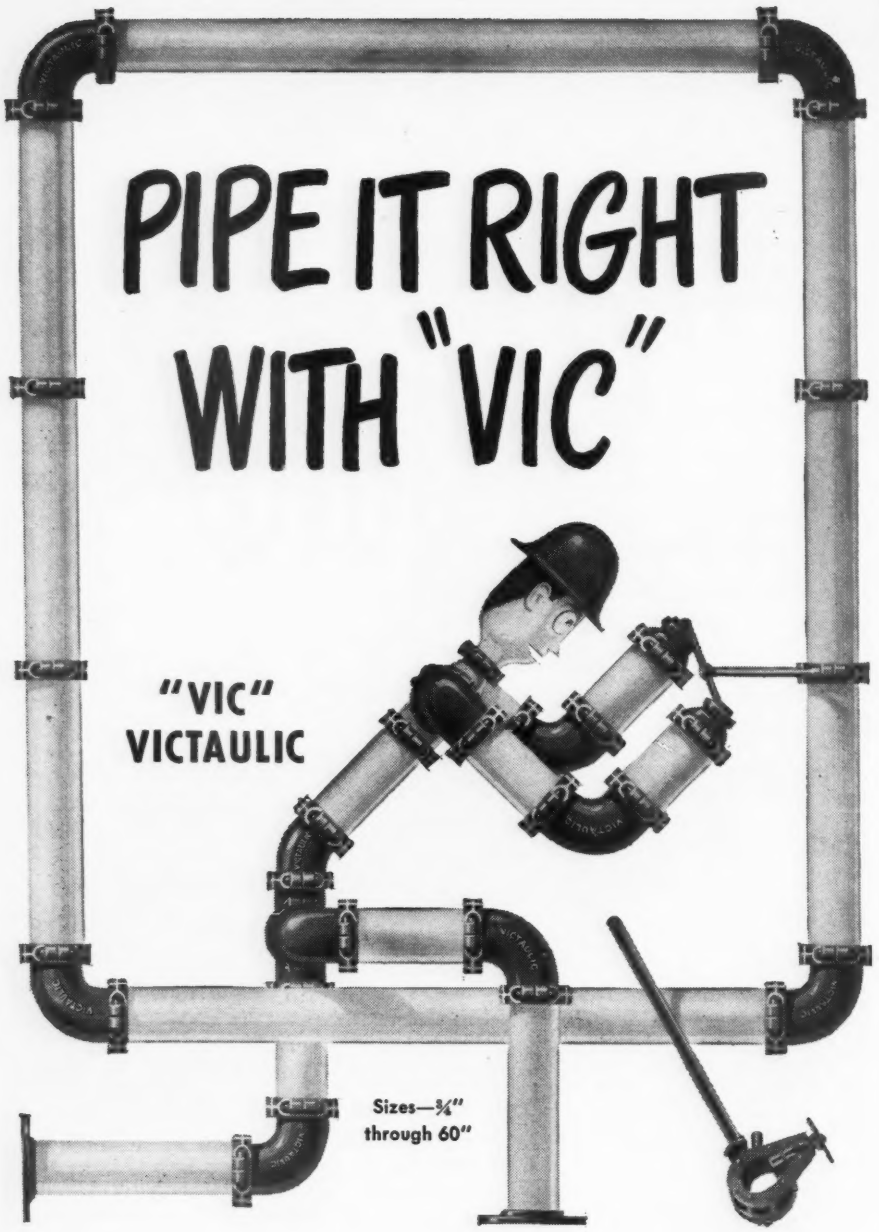

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26TH VICTAULIC YEAR

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The easiest way to make ends meet
VICTAULIC
PIPE COUPLINGS AND FITTINGS

of a data sheet offered by E. F. Houghton & Company, 303 West Lehigh Avenue, Philadelphia 33, Pa. A heavy paste, it combines high-melting-point waxes and fats with a colloidal pigment. Parts are immersed in a solution of the compound and are ready to be drawn after draining and drying. It serves as a substitute for the liming process.

Instruments for measuring and regulating fluid density and specific gravity in industrial manufacturing processes are illustrated and described in Catalogue 76 issued by Fischer & Porter Company. Among the new designs available are submerged float instruments for use in vessels under pressure or vacuum, open bubblers, and closed diaphragm and hydrometer types. The publication will be sent upon request to the company at County Line Road, Hatboro, Pa.

Special shapes of stainless-steel wire, rod, and strip metal are described in a technical data sheet issued by Alloy Metal Wire Company, Inc., Prospect Park, Pa. Intended for purchasing agents, estimators, engineers, and research and production men, it shows how such stock can be used to eliminate many of the machining operations otherwise necessary in manufacturing processes. A large variety of shapes are available and most of them can be supplied in coil form or in straightened and cut lengths.

Hunter Spring Company, 1 Spring Avenue, Lansdale, Pa., has issued a bulletin—No. 310-1C—describing an unusual type of clamp for industrial use. It is in the form of the Hunter Neg'ator which, according to the company was the first elastic member ever to exhibit negative or constant force-deflection characteristics. Among the distinctive properties of the new clamp are: constant pressure regardless of thickness of work, automatic take-up, and great extensibility and flexibility. The bulletin pictures applications and gives design data.

Arthur D. Little, Inc., a research firm, has published an informative booklet on the services its engineers and chemists, professionally trained in economic appraisal, can render businessmen faced with policy decisions. It tells how its staff can help executives who are faced with such problems as diversification and growth, marketing effectiveness, product acceptance, selecting plant sites, revitalizing product lines, appraising trends, etc. A copy can be obtained from the company at 30 Memorial Drive, Cambridge 42, Mass.

Black, Sivalls & Bryson, Inc., 720 Delaware Street, Kansas City 6, Mo., will send to interested persons a copy of a catalogue describing chemical feeders designed for industrial processes that call for small and precise quantities of chemicals. Originally designed for pumping emulsion-breaking chemicals into crude oils, the units are now being used for such purposes as feeding antifreeze or water solvents into gas lines and injecting chemicals into boiler-feed water. Entirely automatic, they are operated with compressed air or gas at 25 to 1000 psi.

High-speed synchronous motors and generators are covered in two bulletins obtainable from General Electric Company, Schenectady 5, N. Y. GEA-5415 deals with generators rated at from 12½ to 1250 kva. and operating at speeds from 1800 to 514 rpm. They are suitable for standby service or as portable prime sources of power in widespread fields of application. GEA-5426 describes 2- and 3-phase 60 cycle motors of 20 to 1500 hp. at 1800 rpm., as well as proportional horsepower ratings for slower speeds down through 514 rpm.